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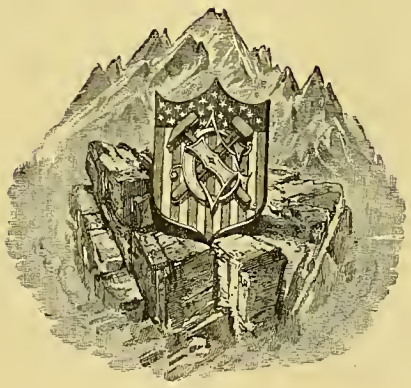
CAMBRIAN BRACHIOPODA

BY

CHARLES D. WALCOTT



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CAMBRIAN BRACHIOPODA.

By Charles D. Walcott.

INTRODUCTION.

PREPARATION AND SCOPE.

It was not until after the preparation of the preliminary memoir on the fauna of the Lower Cambrian or *Olenellus* zone[a] that I began to think seriously of undertaking the systematic study of the Cambrian faunas of the world. The second extended contribution was the memoir on the fossil Medusæ,[b] after which studies were continued on the Brachiopoda. Administrative duties have greatly interfered with the prosecution of the work, but by taking advantage of all opportunities, both in the field and office, some progress has been made from year to year. The work is not so complete as it might be in its discussion of genera and species, details of evolution, and the relations of the Cambrian brachiopod fauna to Ordovician and later faunas. My main purpose has been to make the results of the investigation of value to the student of Cambrian faunas and to the stratigraphic geologist.

This monograph includes the description of 44 genera, 15 subgenera, 477 species, and 59 varieties of Cambrian Brachiopoda, and of 3 genera, 1 subgenus, 42 species, and 1 variety of Ordovician Brachiopoda. Of the Cambrian forms, 10 genera, 2 subgenera, 21 species, and 1 variety persist into the Ordovician. (See pp. 98–113 for complete tables giving distribution.)

In this paper the Brachiopoda are treated in three ways—historically, geologically, and zoologically. Historically the treatment comprises (1) a bibliography and (2) a table of synonymic reference, giving a completely cross-referenced list of described species with the present generic and specific reference of each. Geologically the distribution of the Brachiopoda is considered under the following headings: (1) General geographic and stratigraphic distribution; (2) detailed geographic distribution; (3) detailed stratigraphic distribution; (4) habitat; and (5) fossil localities. Zoologically the discussion covers (1) the physical characters of the Brachiopoda; (2) their distribution; (3) their evolution; and (4) their classification. Lastly come the detailed descriptions of genera and species and the illustrative plates.

ACKNOWLEDGMENTS.

In the course of the investigations of the Cambrian brachiopods during the past ten years I have received assistance in various forms and degrees from many individuals in all sections of the world where the Cambrian strata and faunas occur. To all I return my most grateful acknowledgment and sincere thanks. If any who have assisted me are overlooked in these acknowledgments, I beg leave to assure them that it is not by intention.

Dr. Ferdinand Schmidt, of the Royal Institution of St. Petersburg, sent many specimens and valuable notes on the range of the species in the Upper Cambrian and Lower Ordovician beds of the Baltic provinces of Russia.

Dr. A. Mickwitz, of Reval, Esthonia, Russia, sent material from the *Obolus* beds of Russia.

[a] Walcott, C. D., Fauna of the Lower Cambrian or *Olenellus* zone: Tenth Ann. Rept. U. S. Geol. Survey, pt. 1 1890, pp. 509–763.
[b] Walcott, C. D., Fossil Medusæ: Mon. U. S. Geol. Survey, vol. 30, 1898.

Mr. J. F. Nery Delgado, of the Geological Survey of Portugal, presented photographs of several of the Lower Cambrian brachiopods described by him from Portugal, also a specimen of the new form *Delgadella lusitanica*.

Dr. Charles Barrois, of the University of Lille, France, gave information in relation to the Cambrian faunas of Spain and France.

Dr. Karl A. Grönwall, of the Geological Survey of Denmark, made a collection of Cambrian fossils for me in Bornholm, among which were fine representatives of the brachiopods described by him in his memoir on the *Paradoxides* fauna of Bornholm.

Dr. J. F. Pompeckj, of the University of Hohenheim, Wurttemberg, Germany, was always ready to give information and assistance.

Dr. T. H. Holland, director of the Geological Survey of India, generously loaned for study the collection of brachiopods from the Cambrian formations of the Salt Range, and gave me the opportunity of studying and illustrating Doctor Waagen's types.

Prof. Walter Howchin, of the University of Adelaide, South Australia, sent for study and illustration all the types of Cambrian fossils described by Messrs. R. Etheridge, jr., and Ralph Tate.

As a result of the expedition of the Carnegie Institution of Washington to China under the direction of Mr. Bailey Willis, assisted by Mr. Eliot Blackwelder, large collections of fossils were made from many faunal horizons of the Cambrian, and among them the various brachiopods described in this volume.

Dr. W. C. Brögger, of the University of Christiania, Norway, very generously loaned the types described by him in "Die Silurischen Etagen 2 und 3," also duplicate material of Cambrian brachiopods which he had collected at various localities in Norway.

Dr. N. Olof Holst, of the Geological Survey of Sweden, very kindly took charge of the making of collections of Cambrian fossils for me by Mr. G. Schmalensee, a collector of the Survey, and also permitted the sending of specimens for study and in exchange.

Dr. Joh. Chr. Moberg, of Lund, Sweden, both loaned and presented material for study.

Through the courtesy of Dr. Carl Wiman, of Upsala, Sweden, I had the opportunity of studying the Cambrian brachiopods described by him from the North Baltic region. He not only sent me the specimens, but also answered inquiries in relation to certain facts concerning them which did not appear in the text of his report.

I am greatly indebted to the Geological Survey of Canada for the loan of many of the types in the collections of the Survey museum. Prof. J. F. Whiteaves and Dr. Henry M. Ami were especially kind in selecting and forwarding the specimens desired.

Sir William E. Dawson permitted me to look over the collection of the McGill University museum, and later Dr. Frank D. Adams sent specimens of the Cambrian brachiopods in the collection.

For many years before the sale of his collection, Dr. George F. Matthew, of St. John, New Brunswick, frequently loaned me his types and study material, and also when I visited New Brunswick directed me to the most favorable localities for collecting material both in New Brunswick and Cape Breton. When his collections went to the University of Toronto, Prof. W. A. Parks sent to me from them the various types that I needed for study and illustration.

Prof. Alexander Agassiz permitted me to study the collections of Cambrian brachiopods in the Museum of Comparative Zoology, and also to take to Washington and have illustrations made of a number of specimens, especially those from Bohemia.

Prof. J. M. Clarke, director of the New York State Museum, Albany, N. Y., was most courteous in lending material and giving information relating to it.

Mr. W. A. Finkelnburg, of Winona, Minn., sent material from his collection, and also made collections from the "St. Croix sandstone" at several localities in Minnesota which enabled me to add very materially to the description of the Cambrian brachiopods of Minnesota.

Prof. Alpheus Hyatt, of the Boston Museum of Natural History, lent material he collected on the coast of Labrador, and he was always ready to discuss problems connected with the life history and evolution of the Brachiopoda.

To no one am I more indebted than to Prof. Charles Schuchert, of Yale University, whose suggestions and comments, made in response to questions submitted to him, and also as the result of examining the plates and the preliminary draft of the zoological discussion, have been most helpful.

From year to year material for study was brought in by various members of the United States Geological Survey as opportunity offered, and large collections were made in the Cordilleran area of the United States by Mr. S. Ward Loper, of the Wesleyan University museum. I collected personally from various parts of the United States and Canada, England, and Wales, being assisted in the Cordilleran area by Mr. F. B. Weeks and Mr. Lancaster D. Burling.

During the course of the preparation of this monograph I have received from time to time effective assistance from members of the United States Geological Survey, especially those directly acting as my assistants. When studying the Acrotretidæ Dr. George H. Girty selected material for illustration and also made preliminary notes on some of the species. Miss Elvira Wood separated and classified the brachiopods collected in 1905–6, directed the preparation of drawings, and, in 1906, revised the proof of the plates, which were printed at that time.

Mr. Lancaster D. Burling, of the United States National Museum, revised, verified, and tabulated the synonymy and localities and assisted in many ways in the final make-up of the text of the volume from 1907 to 1912.

At my request Mr. E. O. Ulrich, of the United States Geological Survey, carefully read the zoological discussion and made notes that led me to make several modifications, especially in relation to the protrematous genera. I have included in the text his observations on the spondylium.

To Mr. R. S. Bassler, of the United States National Museum, I am indebted for a number of thin sections of the shells of Cambrian brachiopods and a few Ordovician orthoids and for notes on the sections.

The drawings have been prepared mainly by Miss Frances Wieser, of the United States Geological Survey. The plates are the evidence of her faithful work.

HISTORICAL DATA.

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[a] Since this reference was made and used in the monograph it has been noticed that the section on the Paleozoic (pp. 136–152) is credited to Blackwelder.

SYNONYMIC REFERENCES.

The following table contains, arranged alphabetically by genera, subgenera, species, and varieties, a list of the Brachiopoda referred to in this monograph, as they occur in the literature, and gives the present reference of each:

List, by genera, subgenera, species, and varieties, of the references given in the synonymy, with the present reference of each.

A.

	Present reference.
abavia [Acrothele], Matthew [1902b, pp. 398–400]	Acrothele avia.
Matthew [1903, pp. 100–101]	Do.
abnormis [Syntrophia], Walcott [1905a, pp. 289–290]	Huenella abnormis.
acadica [Obolus], Walcott [1905a, pp. 324–325]	Obolus acadicus.
Acritis Dall [1877, p. 11]	Obolus (Acritis).
Oehlert [1887, p. 1264]	Do.
Volborth [1869, pp. 212–217]	Do.
(Acritis) [Obolus], Mickwitz [1896, pp. 205–206]	Do.
Walcott [1901, p. 683]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
Acritis antiquissima Gagel [1890, p. 22]	Obolus (Acritis) antiquissimus.
Hall and Clarke [1892c, p. 82]	Do.
Volborth [1869, pp. 212–217]	Do.
(Acritis) antiquissimus [Obolus], Mickwitz [1896, pp. 206–213]	Do.
(Acritis) antiquissimus ventrosus [Obolus], Mickwitz [1896, pp. 213–214]	Do.
(Acritis?) rugatus [Obolus], Walcott [1901, p. 694]	Obolus (Acritis?) rugatus.
Acrothele Davidson [1883, pp. 213–214]	Acrothele.
Grabau and Shimer [1907, p. 200]	Do.
Hall and Clarke [1892a, pp. 249–250]	Do.
Hall and Clarke [1892b, pp. 565–566]	Do.
Hall and Clarke [1892c, pp. 98–101]	Do.
Linnarsson [1876, pp. 20–21]	Do.
Matthew [1903, pp. 103–105]	Do.
Oehlert [1887, pp. 1269–1270]	Do.
Walcott [1886b, pp. 107–108]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 146]	Do.
Zittel [1880, p. 665]	Do.
Acrothele abavia Matthew [1902b, pp. 398–400]	Acrothele avia.
Matthew [1903, pp. 100–101]	Do.
Acrothele artemis Walcott [1908d, p. 82]	Acrothele artemis.
Acrothele avia Matthew [1899b, pp. 202–203]	Acrothele avia.
Matthew [1902b, pp. 396–398]	Do.
Matthew [1903, pp. 55 and 98–99]	Do.
Acrothele avia-puteis Matthew [1902b, p. 398]	Acrothele avia puteis.
Matthew [1903, p. 100]	Do.
Acrothele barbata Moberg and Segerberg [1906, pp. 67–68]	Acrothele ceratopygarum.
Acrothele bellapunctata Walcott [1908d, pp. 82–83]	Acrothele bellapunctata.
Acrothele bellula Walcott [1897b, pp. 716–717]	Acrothele bellula.
Acrothele bergeroni Walcott [1908d, pp. 83–84]	Acrothele bergeroni.
Acrothele bohemica Hall and Clarke [1892c, p. 101]	Acrothele bohemica.
Pompeckj [1896b, pp. 509–511]	Do.
Walcott [1886b, p. 107]	Do.
Acrothele borgholmensis Walcott [1908d, pp. 84–85]	Acrothele borgholmensis.
Acrothele ceratopygarum Moberg and Segerberg [1906, p. 67]	Acrothele ceratopygarum.
Acrothele ceratopygonum Walcott [1902, p. 598]	Do.
Acrothele colleni Walcott [new]	Acrothele colleni.
Acrothele coriace Brögger [1878, p. 76]	Acrothele coriacea.
Acrothele coriacea Grönwall [1902, p. 40]	Do.
Linnarsson [1876, pp. 21–23]	Do.
Acrothele decipiens Walcott [1897b, p. 716]	Acrothele decipiens.
Acrothele? dichotoma Walcott [1884b, pp. 14–15]	Acrothele dichotoma.
Acrothele gamagei Grabau [1900, pp. 615–617]	Acrothele gamagei.
Grabau and Shimer [1907, p. 200]	Do.
Shimer [1907, pp. 176 and 177]	Do.

	Present reference.
Acrothele granulata Davidson [1883, p. 214]	Acrothele (Redlichella) granulata.
Hall and Clarke [1892c, pp. 100–101]	Do.
Linnarsson [1876, p. 24]	Do.
Linnarsson [1877, pp. 373–374]	Do.
Swanston [1877, Pl. VII, fig. 20a–c]	Do.
Swanston [1886, Pl. VII, fig. 20a–c]	Do.
Walcott [1886b, p. 109]	Do.
Acrothele inchoans Matthew [1902b, p. 404]	Acrotreta inchoans.
Matthew [1903, p. 103]	Do.
Acrothele intermedia Grönwall [1902, p. 39]	Acrothele intermedia.
Linnarsson [1879, pp. 25–27]	Do.
Acrothele levisensis Walcott [1908d, p. 85]	Acrothele levisensis.
Acrothele matthewi Grabau and Shimer [1907, p. 200, fig. 234f]	Acrothele matthewi.
Grabau and Shimer [1907, p. 200, fig. 234g]	Acrothele prima.
Hall and Clarke [1892a, Pl. III, fig. 24]	Acrothele matthewi.
Hall and Clarke [1892c, pp. 99 and 100]	Do.
Matthew [1886, pp. 39–41]	Do.
Matthew [1895a, p. 128]	Do.
Matthew [1902b, pp. 397 and 402]	Do.
Matthew [1903, p. 104]	Do.
Walcott [1884a, p. 15]	Do.
Walcott [1886b, p. 109]	Do.
Walcott [1891a, p. 609]	Do.
Acrothele matthewi costata Matthew [1895a, p. 128]	Acrothele prima costata.
Matthew [1902b, p. 397]	Do.
Matthew [1903, p. 104]	Do.
Acrothele matthewi eryx Walcott [1905b, p. 11]	Acrothele matthewi eryx.
Acrothele matthewi lata Hall and Clarke [1892a, Pl. III, figs. 25 and 26]	Acrothele matthewi lata.
Hall and Clarke [1892c, Pl. III, figs. 26–28]	Do.
Matthew [1886, p. 41]	Do.
Matthew [1895a, Pl. V, figs. 8a–b]	Do.
Matthew [1903, p. 104]	Do.
Acrothele matthewi multicostata Matthew [1897b, p. 168]	Acrothele matthewi multicostata.
Acrothele matthewi prima Hall and Clarke [1892a, Pl. III, fig. 27]	Acrothele prima.
Hall and Clarke [1892c, Pl. III, fig. 25]	Do.
Matthew [1886, p. 41]	Do.
Matthew [1895a, Pl. V, figs. 7a–b]	Do.
Matthew [1902b, pp. 397 and 402]	Do.
Matthew [1903, p. 104]	Do.
Acrothele? minuta Walcott [1905a, p. 303]	Acrothele? minuta.
Acrothele panderi Walcott [new]	Acrothele panderi.
Acrothele pretiosa Walcott [1898b, p. 402]	Acrothele pretiosa.
Acrothele primæva Pompeckj [1896b, p. 603]	Acrothele primæva.
Acrothele proles Matthew [1902b, pp. 400–401]	Acrothele proles.
Matthew [1903, pp. 60 and 102–103]	Do.
Acrothele quadrilineata Pompeckj [1896b, p. 511]	Acrothele quadrilineata.
Acrothele rarus Walcott [1905a, pp. 303–304]	Acrothele rara.
Acrothele spurri Walcott [1908d, pp. 86–87]	Acrothele spurri.
Acrothele subsidua Beecher [1891, Pl. XVII, fig. 12]	Acrothele subsidua.
Grabau and Shimer [1907, p. 200]	Do.
Hall and Clarke [1892c, pp. 100 and 103]	Do.
Matthew [1902c, p. 110]	Do.
Matthew [1903, p. 103]	Acrothele spurri.
Walcott [1886b, pp. 108–109, Pl. IX, figs. 4a–c]	Acrothele subsidua. The paragraph on page 109 includes reference to this species and to Acrothele spurri.
Walcott [1886b, p. 109, Pl. IX, fig. 4]	Acrothele spurri. The paragraph on page 109 includes reference to this species and to Acrothele subsidua.
Walcott [1891a, p. 608, Pl. LXX, fig. 1]	Acrothele spurri. The text includes reference to this species and to Acrothele subsidua.

	Present reference.
Acrothele subsidua Walcott [1891a, pp. 608–609, Pl. LXX, figs. 1a-c]	Acrothele subsidua. The text includes reference to this species and to Acrothele spurri.
White [1880, p. 47]	Acrothele subsidua.
Acrothele subsidua hera Walcott [1908d, p. 87]	Acrothele subsidua hera.
Acrothele subsidua lævis Walcott [new]	Acrothele subsidua lævis.
Acrothele turneri Walcott [1908d, pp. 87–88]	Acrothele turneri.
Acrothele villaboimensis Delgado [1904, p. 365]	Acrothele villaboimensis.
Acrothele woodworthi Walcott [1908d, p. 88]	Acrothele woodworthi.
Acrothele yorkensis Walcott [1908d, pp. 88–89]	Acrothele yorkensis.
Acrothele sp. undt. Walcott [new]	Acrothele sp. undt. a.
Acrothele sp. Moberg [1892b, pp. 114–115]	Acrothele sp. undt. b.
Pompeckj [1896b, p. 603]	Botsfordia? barrandei (in part) and Acrothele bergeroni (in part).
Acrothele (Redlichella) Walcott [1908d, pp. 89–90]	Acrothele (Redlichella).
Walcott [1908e, Pl. XI, aud pp. 142 and 146]	Do.
Acrothyra Matthew [1901b, pp. 303–304]	Acrothyra.
Matthew [1902c, p. 104]	Do.
Matthew [1903, pp. 85–86]	Do.
Matthew [1903, pp. 88–89]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 146]	Do.
Acrothyra? inflata Matthew [1901b, p. 304]	Acrotreta inflata.
(Acrothyra?) inflata [Lingulella], Matthew [1902b, p. 390]	Do.
Acrothyra minor Walcott [1905a, p. 303]	Acrothyra minor.
Acrothyra proavia Matthew [1902b, pp. 386–388]	Acrothyra proavia.
Matthew [1903, pp. 53–55]	Do.
Acrothyra proavia crassa Matthew [1902b, pp. 389–390]	Do.
Matthew [1903, p. 94]	Do.
Acrothyra proavia prima Matthew [1901b, p. 303]	Do.
Matthew [1902b, p. 389]	Do.
Matthew [1903, pp. 58, 86, and 93]	Do.
Acrothyra signata Matthew [1902b, pp. 381–382]	Acrothyra signata.
Matthew [1903, p. 87]	Do.
Acrothyra signata orta Matthew [1902b, pp. 385–386]	Acrothyra signata orta.
Matthew [1903, pp. 89–90]	Do.
Acrothyra signata prima Matthew [1902b, pp. 382–383]	Acrothyra signata prima.
Matthew [1903, p. 73]	Do.
Acrothyra (signata) sera Matthew [1902b, pp. 383–384]	Acrothyra sera.
Acrothyra signata sera Matthew [1903, p. 56]	Do.
Matthew [1903, pp. 87–88]	Do.
Acrothyra signata tarda Matthew [1902b, pp. 384–385]	Do.
Matthew [1903, p. 89]	Do.
Acrotreta Dall [1877, p. 12]	Acrotreta.
Davidson [1853, p. 133]	Do.
Davidson [1871, p. 343]	Do.
Grabau and Shimer [1907, p. 199]	Do.
Hall and Clarke [1892a, p. 250]	Do.
Hall and Clarke [1892b, p. 566]	Do.
Hall and Clarke [1892c, pp. 101–104]	Do.
Kutorga [1848, pp. 259, 260, and 275]	Do.
Matthew [1902b, p. 390]	Do.
Matthew [1903, pp. 94 and 96–97]	Do.
Morris [1849, pp. 316 and 318]	Do.
Oehlert [1887, p. 1266]	Do.
von Seebach [1865, p. 341]	Do.
Walcott [1884b, pp. 16–17]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 146]	Do.
Zittel [1880, p. 666]	Do.
Acrotreta argenta Walcott [1902, pp. 580–581]	Acrotreta argenta.
Acrotreta attenuata Meek [1873, p. 463]	Acrotreta attenuata (in part), A. attenuata var. (in part), and A. idahoensis (in part).
Walcott [1905a, p. 298]	Acrotreta attenuata.

	Present reference.
Acrotreta attenuata var.? Walcott [1905a, p. 298]	Acrotreta attenuata var.?
Acrotreta babel Barrande [1879b, Pl. XCV, figs. VII: 1-2]	Acrotreta babel.
Acrotreta baileyi Hall and Clarke [1892a, Pl. III, figs. 28-30]	Acrotreta baileyi.
Hall and Clarke [1892c, p. 102]	Do.
Matthew [1886, pp. 36-37]	Do.
Matthew [1902b, p. 395]	Do.
Matthew [1903, p. 97]	Do.
Walcott [1902, pp. 581-582]	Do.
Acrotreta baileyi? Matthew [1892, p. 43]	Acrotreta bisecta.
Acrotreta bellatula Walcott [1908d, pp. 93-94]	Acrotreta bellatula.
Acrotreta bisecta Matthew [1901a, pp. 275-276]	Acrotreta bisecta.
Matthew [1902b, p. 394]	Do.
Matthew [1903, pp. 186-187]	Do.
Walcott [1902, p. 582]	Do.
Walcott [1905a, pp. 298-299]	Do.
Acrotreta? cancellata Walcott [1905a, p. 299]	Acrotreta?? cancellata.
Acrotreta carinata Moberg and Segerberg [1906, p. 66]	Acrotreta carinata.
(Acrotreta?) ceratopygarum [Discina], Brögger [1882, p. 47]	Acrothele ceratopygarum.
Acrotreta circularis Moberg and Segerberg [1906, pp. 65-66]	Acrotreta circularis.
Acrotreta claytoni Walcott [1902, p. 583]	Acrotreta claytoni.
Acrotreta concentrica Walcott [1902, p. 583]	Acrotreta concentrica.
Acrotreta conula Walcott [1902, p. 584]	Acrotreta conula.
Acrotreta convexa Walcott [1902, p. 584]	Acrotreta convexa.
Acrotreta curvata Walcott [1902, p. 584]	Acrotreta curvata.
Acrotreta definita Walcott [1902, pp. 584-585]	Acrotreta definita.
Acrotreta depressa Walcott [1908c, p. 245]	Acrotreta depressa.
Acrotreta dichotoma Hall and Clarke [1892c, pp. 100 and 103]	Acrothele dichotoma.
Walcott [1886b, p. 107]	Do.
Acrotreta eggegrundensis Walcott [1905a, pp. 299-300]	Acrotreta eggegrundensis.
Wiman [1902, p. 55]	Do.
Acrotreta emmonsi Walcott [1905a, p. 300]	Acrotreta emmonsi.
Acrotreta gemma Billings [1865a, pp. 216-217]	Acrotreta gemma.
Grabau and Shimer [1907, p. 199]	Acrotreta primæva.
Hall and Clarke [1892c, p. 102, fig. 55]	Acrotreta curvata.
Hall and Clarke [1892c, p. 102, figs. 56 and 57]	Acrotreta idahoensis alta.
Walcott [1884b, pp. 17-18]	Acrotreta attenuata (in part), A. pyxidicula (in part), A. curvata (in part), and A. idahoensis alta (in part). The text includes all four species, but the last two were the only ones figured.
Walcott [1884b, pp. 17-18, Pl. I, figs. 1a-b]	Acrotreta idahoensis alta.
Walcott [1884b, pp. 17-18, Pl. I, figs. 1d-e]	Acrotreta curvata.
Walcott [1886b, pp. 98-99]	Acrotreta attenuata (in part), A. pyxidicula (in part), and A. primæva (in part). The text includes all three species, but the last was the only one figured.
Walcott [1886b, pp. 98-99, Pl. VIII, figs. 1, 1a-b]	Acrotreta primæva.
Walcott [1891a, p. 608]	Acrotreta attenuata (in part), A. pyxidicula (in part), A. curvata (in part), A. idahoensis alta (in part), and A. primæva (in part). The text includes all five species, but the last three were the only ones figured.
Walcott [1891a, p. 608, Pl. LXVII, figs. 5 and 5a]	Acrotreta idahoensis alta.
Walcott [1891a, p. 608, Pl. LXVII, fig. 5b]	Acrotreta curvata.
Walcott [1891a, p. 608, Pl. LXVII, 5c-e]	Acrotreta primæva.
Walcott [1899, p. 449]	Acrotreta attenuata (in part), A. pyxidicula (in part), A. curvata (in part), A. idahoensis alta (in part), and A. primæva (in part). The text includes all five species, but the last three were the only ones figured.
Walcott [1899, p. 449, Pl. LXII, figs. 2, 2b, and 2d]	Acrotreta primæva.

	Present reference.
Acrotreta gemma Walcott [1899, p. 449, Pl. LXII, figs. 2a and 2c]	Acrotreta idahoensis alta.
Walcott [1899, p. 449, Pl. LXII, fig. 2e]	Acrotreta curvata.
Acrotreta gemma depressa Matthew [1902c, p. 109]	Acrotreta depressa.
Walcott [1889c, pp. 441–442]	Do.
Acrotreta gemmula Matthew [1894, pp. 87–88]	Acrotreta gemmula.
Matthew [1895a, p. 126]	Do.
Matthew [1903, p. 97]	Do.
Acrotreta gracia Walcott [1902, pp. 586–587]	Acrotreta gracia.
Acrotreta? gulielmi Matthew [1886, pp. 37–39]	Discinopsis gulielmi.
Acrotreta idahoensis Walcott [1902, p. 587]	Acrotreta idahoensis.
Acrotreta cf. idahoensis Walcott [new]	Acrotreta cf. idahoensis.
Acrotreta idahoensis alta Walcott [1902, p. 588]	Acrotreta idahoensis alta.
Acrotreta idahoensis sulcata Walcott [1902, p. 588]	Acrotreta idahoensis sulcata.
Acrotreta inchoans Pompeckj [1896a, p. 3]	Acrotreta inchoans.
Acrotreta inflata Walcott [1902, pp. 588–589]	Acrotreta inflata.
Acrotreta kutorgai Walcott [1902, pp. 589–590]	Acrotreta kutorgai (in part) and A. rudis (in part).
Acrotreta liani Walcott [1905a, p. 300]	Acrotreta lisani.
Acrotreta limöensis Wiman [1902, p. 54]	Acrotreta uplandica limöensis.
Acrotreta marjumensis Walcott [1908d, pp. 94–95]	Acrotreta marjumensis.
Acrotreta microscopica missouriensis Walcott [1902, p. 590]	Acrotreta microscopica missouriensis.
Acrotreta microscopica tetonensis Walcott [1902, p. 590]	Acrotreta microscopica tetonensis.
Acrotreta minuta Walcott [1901, p. 673]	Linnarssonella minuta.
Acrotreta miser Walcott [1902, pp. 590–591]	Acrotreta misera.
Acrotreta neboensis Walcott [1905a, pp. 300–301]	Acrotreta neboensis.
Acrotreta? nicholsoni Davidson [1868, pp. 313–314]	Acrotreta nicholsoni.
Davidson [1871, pp. 343–344]	Do.
Acrotreta nicholsoni Davidson [1883, p. 213]	Do.
Hall and Clarke [1892c, p. 103]	Do.
Swanston [1877, Pl. VII, figs. 21a–c]	Do.
Swanston [1886, Pl. VII, figs. 21a–c]	Do.
Acrotreta sp. cf. nicholsoni Matley [1902, p. 142]	Acrotreta sabrinæ.
Acrotreta nox Walcott [1905a, p. 301]	Acrotreta nox.
Acrotreta œlandica Westergård [1909, p. 76]	Acrotreta œlandica.
Acrotreta ophirensis Walcott [1902, pp. 591–592]	Acrotreta ophirensis.
Acrotreta cf. ophirensis Walcott [new]	Acrotreta cf. ophirensis.
Acrotreta ophirensis descendens Walcott [1908d, p. 95]	Acrotreta ophirensis descendens.
Acrotreta ophirensis rugosus Walcott [1902, p. 592]	Acrotreta ophirensis rugosa.
Acrotreta ovalis Walcott [1902, p. 592]	Acrotreta ovalis.
Acrotreta pacifica Walcott [1905a, p. 301]	Acrotreta pacifica.
Acrotreta papellata-prima Matthew [1902b, pp. 391–392]	Acrothyra sera.
Acrotreta papillata Matthew [1902b, pp. 390–391]	Do.
Matthew [1903, p. 95]	Do.
Acrotreta papillata lata Matthew [1903, pp. 95–96]	Do.
Acrotreta papillata-prima Matthew [1903, pp. 73–74]	Do.
Acrotreta papillata var. Matthew [1902b, p. 391]	Do.
Acrotreta parvula Walcott [1902, p. 592]	Acrotreta parvula.
Acrotreta primaæa Walcott [1902, p. 593]	Acrotreta primæva.
Acrotreta proavia Matthew [1899b, p. 203]	Acrothyra proavia.
Acrotreta pyxidicula White [1874, p. 9]	Acrotreta pyxidicula.
White [1877, pp. 53–54]	Do.
Acrotreta recurva Kutorga [1848, pp. 277–278]	Volborthia recurva.
Acrotreta rudis Walcott [1908d, pp. 95–96]	Acrotreta rudis.
Acrotreta (?) sabrinæ Matley [1902, p. 143]	Acrotreta sabrinæ.
Acrotreta (?) sabrinæ malvernensis Matley [1902, pp. 143–144]	Do.
(Acrotreta?) sagittalis [Obolella], Moberg and Segerberg [1906, p. 64]	Acrotreta sagittalis.
Acrotreta cf. sagittalis Walcott [new]	Acrotreta cf. sagittalis.
Acrotreta sagittalis magna Walcott [1902, pp. 595–596]	Acrotreta sagittalis magna.
Acrotreta sagittalis taconica Walcott [1902, pp. 596–597]	Acrotreta sagittalis taconica.
Acrotreta schmalenseei Walcott [1902, pp. 597–598]	Acrotreta schmalenseei.
Acrotreta seebachi Moberg and Segerberg [1906, pp. 66–67]	Acrotreta seebachi.
Walcott [1902, pp. 598–599]	Do.
Acrotreta shantungensis Walcott [1905a, pp. 301–302]	Acrotreta shantungensis.
Acrotreta signalis Walcott [1902, p. 599]	Acrotreta signalis.

	Present reference.
Acrotreta sipo Matthew [1902b, pp. 406–407]	Acrotreta bisecta.
Matthew [1903, pp. 185–186]	Do.
Acrotreta socialis Grönwall [1902, p. 39]	Either Acrotreta schmalenseei or A. socialis. (See p. 712.)
Linnarsson [1876, pp. 16–18]	Acrotreta schmalenseei.
Linnarsson [1877, p. 374]	Either Acrotreta schmalenseei or A. socialis. (See p. 712.)
von Seebach [1865, p. 341]	Acrotreta socialis.
Walcott [1902, pp. 599–600]	Do.
Wallerius [1895, p. 66]	Acrotreta schmalenseei.
Acrotreta cf. socialis Brögger [1882, pp. 46–47, Pl. X, figs. 2, 2a–b]	Acrotreta carinata.
Brögger [1882, pp. 46–47, Pl. X, figs. 3 and 4]	Not referred in this monograph.
Matley [1902, pp. 144–145]	Acrotreta sabrinæ.
Matthew [1902b, pp. 392–394]	Acrotreta sp. undt.
Matthew [1903, pp. 183–185]	Do.
Acrotreta spinosa Walcott [1905a, p. 302]	Acrotreta spinosa.
Acrotreta subconica Davidson [1853, Pl. IX, figs. 271–275]	Acrotreta subconica.
Kutorga [1848, p. 275]	Do.
Meek [1873, p. 463]	Acrotreta attenuata (in part), A. attenuata var. (in part), and A. idahoensis (in part).
Quenstedt [1885, p. 755]	Acrotreta subconica.
von Seebach [1865, p. 341]	Do.
Walcott [1902, pp. 600–601]	Do.
Acrotreta? subsidua White [1874, p. 6]	Acrothele subsidua.
White [1877, pp. 34–36]	Do.
Acrotreta ulrichi Walcott [1908d, pp. 96–97]	Acrotreta ulrichi.
Acrotreta uplandensis Walcott [1905a, p. 302]	Acrotreta uplandica.
Acrotreta uplandica Wiman [1902, p. 54]	Do.
Acrotreta uplandica limonensis Walcott [1905a, p. 303]	Acrotreta uplandica limöensis.
Acrotreta sp. Morris [1849, Pl. VII, figs. 4a–b]	Acrotreta subconica.
Westergård [1909, pp. 57 and 77]	Acrotreta sp. undt.
Acrotreta (Volborthia) Oehlert [1887, p. 1266]	Volborthia.
acuminata [Glossina], Hall and Clarke [1892a, Pl. I, figs. 10 and 11]	Lingulella (Lingulepis) acuminata sequens.
acuminata [Lingula], Billings [1863, p. 102]	Lingulella (Lingulepis) acuminata.
Chapman [1863, p. 187]	Do.
Chapman [1864, p. 159]	Do.
Conrad [1839, p. 64]	Do.
Emmons [1855, p. 203]	Do.
Hall [1847, p. 9]	Do.
acuminata [Lingula (Glossina)], Hall and Clarke [1892c, Pl. I, figs. 1 and 2]	Lingulella (Lingulepis) acuminata sequens.
acuminata [Lingulepis], Dwight [1886, p. 208]	Lingulella (Lingulepis) acuminata.
Matthew [1895b, pp. 257–258]	Do.
Schuchert [1897, p. 259]	Do.
Walcott [1897a, p. 404]	Do.
acuminata meeki [Lingulepis], Delgado [1904, pp. 366–367]	Lingulella delgadoi.
acuminata sequens [Lingulella (Lingulepis)], Walcott [1908d, p. 72]	Lingulella (Lingulepis) acuminata sequens.
acuminatus [Obolus (Lingulepis)], Walcott [1899, p. 443]	Lingulella (Lingulepis) acuminata.
acuminatus [Obolus (Schmidtia)], Mickwitz [1896, pp. 179–183]	Obolus (Schmidtia) acuminatus.
acuminatus alatus [Obolus (Schmidtia)], Mickwitz [1896, pp. 183–184]	Do.
acuminatus humeratus [Obolus (Schmidtia)], Mickwitz [1896, pp. 184–186]	Do.
acuminatus meeki [Obolus (Lingulepis)], Walcott [1899, p. 444]	Lingulella (Lingulepis) acuminata meeki.
acuminatus subtriangularis [Obolus (Schmidtia)], Mickwitz [1896, pp. 186–187]	Obolus (Schmidtia) acuminatus.
acutangula [Lingula], Roemer [1849, p. 420]	Lingulella acutangula.
Roemer [1852, p. 90]	Do.
acutangulus [Lingulepis], Schuchert [1897, p. 259]	Do.
acutangulus [Obolus (Lingulella)], Walcott [1898b, pp. 393 and 394, Pls. XXVII and XXVIII]	Do.
acutus [Obolus (Schmidtia) obtusus], Mickwitz [1896, pp. 172–173]	Obolus (Schmidtia) obtusus.
advena [Obolus?], Barrande [1879b, Pl. XCV, fig. IV]	Obolus? advenus.
æquiputeis [Obolus], Matthew [1902c, p. 94]	Obolus selwyni.
Matthew [1903, p. 139]	Do.
affinis [Lingulella?], Billings [1872b, p. 468]	Obolus (Lingulobolus) affinis.
Billings [1874, p. 67]	Do.
affinis [Lingulella], Billings [1882, pp. 15–16]	Do.

	Present reference.
affinis [Lingulepis], Walcott [1889a, p. 381]	Obolus (Lingulobolus) affinis.
affinis [Lingulobolus], Grabau [1900, pp. 621–622]	Do.
Matthew [1895b, pp. 261–262]	Do.
affinis [Obolus (Lingulobolus)], Walcott [1898a, p. 327]	Do.
affinis cuneata [Lingulobolus], Matthew [1895b, p. 262]	Do.
agnostorum [Lingula], Wallerius [1895, pp. 64–65]	Lingulella agnostorum.
agreste [Orthis (Plectorthis)], Walcott, [1906, p. 570]	Eoorthis agreste.
alabamaensis [Iphidea], Walcott [1897b, pp. 713–714]	Micromitra alabamaensis.
alandensis [Obolus (Westonia)], Walcott [1905a, p. 334]	Obolus (Westonia) ålandensis.
alata? [Kutorgina], Moberg [1892b, p. 113]	Belongs with an undetermined genus.
alata [Syntrophia], Walcott [1905a, p. 290]	Syntrophia alata.
alatus [Obolus (Schmidtia) acuminatus], Mickwitz [1896, pp. 183–184]	Obolus (Schmidtia) acuminatus.
alberta [Billingsella], Schuchert [1897, p. 158]	Nisusia alberta.
alberta [Nisusia], Walcott [1905a, pp. 248–249]	Do.
Walcott [1908c, p. 245]	Do.
alberta [Orthisina], Matthew [1902c, p. 109]	Do.
Walcott [1889c, p. 442]	Do.
alta [Acrotreta idahoensis], Walcott [1902, p. 588]	Acrotreta idahoensis alta.
ambigua [Billingsia?], Ford [1886a, p. 467]	Elkania ambigua.
ambigua [Elkania], Ford [1886b, p. 325]	Do.
Hall and Clarke [1892c, p. 78]	Do.
ambigua [Obolella?], Walcott [1884b, pp. 67–68]	Do.
amii [Nisusia (Jamesella)], Walcott [1905a, p. 252]	Nisusia (Jamesella) amii.
ampla [Lingula], Hall [1863, p. 125]	Lingulella ampla.
Hall [1867, pp. 101–102]	Do.
Owen [1852, p. 583]	Do.
ampla [Lingulella], Schuchert [1897, p. 257]	Do.
amplus [Obolus (Lingulella)], Walcott [1898b, pp. 392 and 394, Pl. XXVIII]	Do.
anceps [Obolus], Walcott [1898b, pp. 388–389]	Obolus anceps.
ancilla [Lingula], Barrande [1879b, Pl. CXI, fig. VI]	Obolus ? ancillus.
angulatus [Obolus (Schmidtia) crassus], Mickwitz [1896, pp. 193–194]	Obolus (Schmidtia) crassus.
anomala [Billingsella?], Walcott [1905a, p. 230]	Wimanella ? anomala.
Anomites lenticularis Wahlenberg [1821, pp. 66–67]	Orusia lenticularis.
antiqua [Lingula], Billings [1856, p. 34]	Lingulella (Lingulepis) acuminata.
Emmons [1842, p. 268]	Do.
Emmons [1863, p. 92]	Do.
Hall [1847, pp. 3–4]	Do.
Hall [1851, pp. 204–205]	Do.
Hall [1862, fig. 2, p. 21]	Do.
Hayden [1862, p. 73]	Do.
James [1895, p. 884]	Do.
Owen [1851, p. 170]	Do.
Rogers [1861, p. 390]	Obolus (Westonia) rogersi.
antiquata [Camarella?], Hall and Clarke [1893b, pp. 220–221]	Swantonia antiquata.
antiquata [Camarella], Walcott [1886b, pp. 122–123]	Do.
Walcott [1891a, p. 613]	Do.
antiquata [Camerella], Billings [1861b, pp. 10–11]	Do.
Billings [1861c, p. 949]	Do.
Billings [1862e, p. 221]	Do.
Billings [1863, fig. 290, p. 284]	Do.
antiquata [Lingula], Emmons [1855, pp. 202–203]	Lingulella (Lingulepis) acuminata.
antiquata [Protorhyncha?], Schuchert [1897, p. 334]	Swantonia antiquata.
antiquata [Swantonia], Walcott [1905a, pp. 296–297]	Do.
antiquissima [Acritis], Gagel [1890, p. 22]	Obolus (Acritis) antiquissimus.
Hall and Clarke [1892c, p. 82]	Do.
Volborth [1869, pp. 212–217]	Do.
antiquissima [Aulonotreta], Hall and Clarke [1892a, figs. 246 and 247, p. 244]	Do.
Hall and Clarke [1892b, figs. 246 and 247, p. 560]	Do.
antiquissimus [Obolus], Eichwald [1859, Pl. XXXVII, figs. 5a–d]	Do.
Eichwald [1860, pp. 928–929]	Do.
antiquissimus [Obolus (Acritis)], Mickwitz [1896, pp. 206–213]	Do.
antiquissimus [Obolus (Lucina)], Eichwald [1843b, pp. 142–144]	Do.
antiquissimus ventrosus [Obolus (Acritis)], Mickwitz [1896, pp. 213–214]	Do.

		Present reference.
apollinis [Obolus],	Billings [1872a, p. 218]	Obolus apollinis.
	Billings [1872c, p. 356]	Do.
	Davidson [1853, figs. 51 and 52, p. 136, and Pl. IX, figs. 280–284]	Do.
	Davidson [1853, Pl. IX, fig. 285]	Obolus (Acritis) antiquissimus.
	Eichwald [1829, p. 274]	Obolus apollinis.
	Eichwald [1840, p. 167]	Do.
	Eichwald [1843b, p. 140]	Do.
	Eichwald [1860, pp. 925–926]	Do.
	Gagel [1890, pp. 21–22]	Do.
	Hall and Clarke [1892a, figs. 247 and 248, p. 242]	Do.
	Hall and Clarke [1892b, figs. 247 and 248, p. 558]	Do.
	Hall and Clarke [1892c, p. 80]	Do.
	Kutorga [1848, pp. 251 and 252]	Do.
	Matthew [1892, pp. 43–44]	Do.
	Mickwitz [1896, pp. 133–137]	Do.
	Moberg and Segerberg [1906, p. 65]	Do.
	Morris [1849, p. 316]	Do.
	Noetling [1883, p. 265]	Do.
	Roemer [1876, Pl. II, figs. 7a–c]	Do.
	Roemer [1885, pp. 23–24 (270–271)]	Do.
	Schmidt [1861, p. 218]	Do.
	de Verneuil [1845, pp. 290–292]	Obolus apollinis (in part), O. apollinis ingricus (in part), Obolus (Acritis) antiquissimus (in part), and Obolus (Mickwitzella) siluricus (in part).
	Walcott [1898b, Pl. XXVI, figs. 3–6]	Obolus apollinis.
	Westergård [1909, p. 56]	Do.
	Zittel [1880, figs. 488a–c, p. 664]	Do.
	Zittel [1880, fig. 488d, p. 664]	Obolus apollinis quenstedti.
apollinis [Ungulites],	Quenstedt [1885, pp. 755 and 756]	Obolus apollinis.
apollinis ingricus [Obolus],	Mickwitz [1896, pp. 137–140]	Obolus apollinis ingricus.
apollinis maximus [Obolus],	Mickwitz [1896, pp. 140–143]	Obolus apollinis maximus.
apollinis quenstedti [Obolus],	Mickwitz [1896, pp. 143–145]	Obolus apollinis quenstedti.
appalachia [Billingsella?],	Walcott [1905a, p. 231]	Billingsella? appalachia.
appalachia [Dicellomus],	Walcott [1905a, p. 314]	Dicellomus appalachia.
appolinus? [Obolus],	Owen [1852, p. 501]	Dicellomus politus.
argenta [Acrotreta],	Walcott [1902, pp. 580–581]	Acrotreta argenta.
argenta [Nisusia (Jamesella)],	Walcott [1905a, p. 252]	Nisusia (Jamesella) argenta.
argia [Syntrophia primordialis],	Walcott [1905a, p. 293]	Syntrophia primordialis argia.
argutus [Obolus (Lingulella)],	Walcott [1898b, p. 396]	Lingulella arguta.
artemis [Acrothele],	Walcott [1908d, p. 82]	Acrothele artemis.
asiatica [Obolella],	Walcott [1905a, p. 297]	Obolella asiatica.
aspera [Lingulella radula],	Matthew [1903, pp. 204–205]	Lingulella radula.
atava [Orthis (Plectorthis?)],	Walcott [1905a, pp. 259–260]	Eoorthis atava.
atava [Rafinesquina?],	Schuchert [1897, p. 338]	Do.
atava [Strophomena],	Matthew [1893b, pp. 102–103]	Do.
atava [Strophomena?],	Moberg and Segerberg [1906, Pl. II, figs. 7, 7a–b]	Do.
atavus [Leptobolus],	Matthew [1899b, pp. 200–201]	Lingulella atava.
	Matthew [1903, pp. 106–109]	Do.
atavus [Obolus (Lingulella)],	Walcott [1902, pp. 609–610]	Do.
atavus insulæ [Leptobolus],	Matthew [1903, pp. 110–112]	Lingulella atava insulæ.
atavus tritavus [Leptobolus],	Matthew [1903, p. 109]	Lingulella torrentis.
atlantica [Obolella],	Burr [1900, p. 47]	Obolella atlantica.
	Gorham [1905, Pl. I, figs. 2a–c]	Do.
	Grabau [1900, pp. 620–621]	Do.
	Grabau and Shimer [1907, p. 188]	Do.
	Matthew [1899d, p. 70]	Do.
	Walcott [1890b, p. 36]	Do.
	Walcott [1891a, p. 611]	Do.
atlantica [Obolella cf.],	Delgado [1904, p. 364]	Obolella? sp. undt. a.
Atrypa? lenticularis	Dalman [1828, pp. 132–133]	Orusia lenticularis.
	Hisinger [1837, p. 76]	Do.

	Present reference.
Atrypa lenticularis Kjerulf [1857, p. 92]	Orusia lenticularis.
Kjerulf [1865, pp. 1 and 3]	Do.
Kjerulf [1879, Pl. XIII]	Do.
atrypoides [Orthis lenticularis], Matthew [1892, p. 48]	Orusia lenticularis atrypoides.
Matthew [1903, p. 217]	Do.
atrypoides [Orthis (Orusia) lenticularis], Walcott [1905a, p. 276]	Do.
attenuata [Acrotreta], Meek [1873, p. 463]	Acrotreta attenuata (in part), A. attenuata var. (in part), and A. idahoensis (in part).
Walcott [1905a, p. 298]	Acrotreta attenuata.
attenuata [Lingula], Bornemann [1891, pp. 437–438]	Lingulella bornemanni.
attenuata var. [Acrotreta], Walcott [1905a, p. 298]	Acrotreta attenuata var.?
auga [Obolus (Lingulella)], Walcott [1898b, pp. 396–397]	Lingulella auga.
Aulonotreta Dall [1877, p. 16]	Obolus (Acritis).
Hall and Clarke [1892a, pp. 243–244]	Obolus (in part) and O. (Acritis) (in part).
Hall and Clarke [1892b, pp. 559–560]	Do.
Hall and Clarke [1892c, p. 82]	Do.
Kutorga [1848, pp. 278–279]	Obolus (in part), O. (Acritis) (in part), and O. (Mickwitzella) (in part).
Morris [1849, pp. 316–317]	Obolus (Acritis).
Aulonotreta antiquissima Hall and Clarke [1892a, figs. 246 and 247, p. 244]	Obolus (Acritis) antiquissimus.
Hall and Clarke [1892b, figs. 246 and 247, p. 560]	Do.
Aulonotreta polita Kutorga [1848, pp. 279–282]	Obolus apollinis (in part), O. apollinis ingricus (in part), and O. (Mickwitzella) siluricus (in part).
Aulonotreta sculpta Dall [1877, p. 16]	Obolus (Acritis) antiquissimus.
Kutorga [1848, pp. 282–283]	Do.
aurora [Lingula], Hall [1861, p. 24]	Obolus (Westonia) aurora.
Hall [1862, p. 21]	Do.
Hall [1863, pp. 126–127]	Do.
Hall [1867, pp. 103–104]	Do.
Sardeson [1896, p. 95]	Do.
aurora [Lingulella], Grabau and Shimer [1907, p. 193]	Do.
Hall [1873, pp. 244–245]	Do.
Hall and Clarke [1892c, Pl. II, figs. 12 and 13]	Do.
aurora [Obolus (Westonia)], Walcott [1901, p. 691]	Do.
aurora var. [Lingula], Hall [1863, pp. 127–128]	Obolus (Westonia) stoneanus.
Hall [1867, pp. 104–106]	Do.
aurora var. [Lingulella], Hall [1873, pp. 244–245]	Do.
avia [Acrothele], Matthew [1899b, pp. 202–203]	Acrothele avia.
Matthew [1902b, pp. 396–398]	Do.
Matthew [1903, pp. 55 and 98–99]	Do.
avia-puteis [Acrothele], Matthew [1902b, p. 398]	Acrothele avia puteis.
Matthew [1903, p. 100]	Do.
Avicula? desquamata Hall [1847, p. 292]	Obolella crassa.

B.

babel [Acrotreta], Barrande [1879b, Pl. XCV, figs. VII: 1–2]	Acrotreta babel.
baileyi [Acrotreta], Hall and Clarke [1892a, Pl. III, figs. 28–30]	Acrotreta baileyi.
Hall and Clarke [1892c, p. 102]	Do.
Matthew [1886, pp. 36–37]	Do.
Matthew [1902b, p. 395]	Do.
Matthew [1903, p. 97]	Do.
Walcott [1902, pp. 581–582]	Do.
baileyi? [Acrotreta], Matthew [1892, p. 43]	Acrotreta bisecta.
baltica [Obolus (Westonia)], Walcott [1905a, p. 334]	Obolus (Westonia) balticus.
barabuensis [Leptæna], Whitfield [1878, p. 60]	Syntrophia barabuensis.
Whitfield [1882, pp. 171–172 and 195]	Do.
barabuensis [Orthis], A. Winchell [1864, p. 228]	Do.
barabuensis [Syntrophia], Hall and Clarke [1893b, p. 216]	Do.
Walcott [1905a, pp. 290–291]	Do.
barbata [Acrothele], Moberg and Segerberg [1906, pp. 67–68]	Acrothele ceratopygarum.
barrandei [Botsfordia?], Walcott [1908d, pp. 77–78]	Botsfordia? barrandei.

	Present reference.
bavarica [Lingula], Barrande [1868a, p. 100]	Obolus? bavaricus.
Barrande [1868b, pp. 690–691]	Do.
bavarica [Orthis], Barrande [1868a, p. 99]	Eoorthis bavarica.
Barrande [1868b, p. 690]	Do.
bella [Iphidea], Billings [1872b, pp. 477–478]	Micromitra (Paterina) bella.
Billings [1874, p. 76]	Do.
Billings [1882, p. 13]	Do.
Clark and Mathews [1906, p. 252]	Do.
Grabau and Shimer [1907, p. 201]	Do.
Hall and Clarke [1892a, p. 249]	Micromitra (Paterina) labradorica swantonensis.
Hall and Clarke [1892c, p. 98, fig. 54]	Micromitra (Paterina) bella. The text includes both M. (P.) bella and M. (P.) labradorica swantouensis.
Hall and Clarke [1892c, p. 98, Pl. IV, figs. 8 and 9]	Micromitra (Paterina) labradorica swantonensis. The text includes both M. (P.) labradorica swantonensis and M. (P.) bella.
Oehlert [1887, p. 1270]	Micromitra (Paterina) bella.
Walcott [1886b, p. 100]	Do.
Walcott [1891a, p. 608]	Do.
bella? [Iphidea], Grabau [1900, pp. 617–618]	Do.
bellapunctata [Acrothele], Walcott [1908d, pp. 82–83]	Acrothele bellapunctata.
bellatula [Acrotreta], Walcott [1908d, pp. 93–94]	Acrotreta bellatula.
belli [Lingula], Billings [1859, pp. 431–432]	Obolus belli.
Billings [1863, figs. 47a–b, p. 124]	Do.
bellula [Acrothele], Walcott [1897b, pp. 716–717]	Acrothele bellula.
bellula [Elkania], Walcott [1905a, p. 323]	Obolus (Fordinia) bellulus.
bellulus [Obolus (Lingulella)], Matthew [1903, p. 205]	Lingulella bellula.
Walcott [1898b, p. 398]	Do.
bellus [Obolus (Lingulella)], Matthew [1903, p. 204]	Lingulella bella.
Walcott [1898b, pp. 397–398]	Do.
Walcott [1901, pp. 685–687]	Lingulella bella (in part), L. concinna (in part), and L. lens (in part).
belti [Linnarssonia], Matley [1902, p. 145]	Acrotreta belti.
belti? [Linnarssonia], Matthew [1892, pp. 42–43]	(?) This species is not specifically referred in this monograph; it does not belong with Acrotreta belti.
belti [Liunarssonia cf.], Matthew [1903, pp. 209–210]	Do.
belti [Obolella], Davidson [1868, pp. 310–311]	Acrotreta belti.
Davidson [1871, pp. 340–341]	Do.
belti [Obolella sagittalis], Davidson [1871, desc. of Pl. L, figs. 15–17]	Do.
belti magna [Linnarssonia], Matthew [1897b, pp. 169–170]	Acrotreta sagittalis magna.
bergeroni [Acrothele], Walcott [1908d, pp. 83–84]	Acrothele bergeroni.
bicensis [Obolus (Lingulella)], Walcott [1901, p. 688]	Botsfordia cælata.
Bicia Walcott [1901, pp. 676–678]	Bicia.
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
Bicia gemma Walcott [1901, pp. 678–680]	Bicia gemma.
Bicia whiteavesi Walcott [1901, p. 680]	Bicia whiteavesi.
billingsana [Lingula], Matthew [1903, p. 205]	Lingulella bellula.
billingsana [Lingulella?], Schuchert [1897, p. 256]	Lingulella grandis (in part) and L. billingsiana (in part).
Billingsella Grabau and Shimer [1907, p. 210]	Billingsella.
Hall and Clarke [1892a, p. 273]	Do.
Hall and Clarke [1892b, p. 589]	Do.
Hall and Clarke [1892c, pp. 230–231]	Billingsella (in part) and Nisusia (in part).
Schuchert [1897, p. 158]	Billingsella (in part), Protorthis (in part), and Nisusia (in part).
Walcott [1905a, pp. 227–229]	Billingsella (in part) and Wimanella (in part).
Walcott [1908e, Pl. XI, and pp. 142 and 148]	Billingsella.
Billingsella alberta Schuchert [1897, p. 158]	Nisusia alberta.
Billingsella? anomala Walcott [1905a, p. 230]	Wimanella ? anomala.

	Present reference.
Billingsella? appalachia Walcott [1905a, p. 231]	Billingsella? appalachia.
Billingsella billingsi Schuchert [1897, p. 158]	Protorthis billingsi.
(Billingsella) billingsi [Protorthis], Grabau and Shimer [1907, p. 211]	Do.
Billingsella bivia Walcott [new]	Billingsella bivia.
Billingsella circe Walcott [1901, p. 673]	Quebecia circe.
Billingsella coloradoensis Grabau and Shimer [1907, p. 210]	Billingsella coloradoensis.
Schuchert [1897, p. 158]	Do.
Walcott [1899, pp. 450–451]	Do.
Walcott [1905a, pp. 231–234]	Do.
Billingsella dice Walcott [1905a, p. 234]	Billingsella dice.
Billingsella exporrecta Walcott [1905a, pp. 234–236]	Billingsella exporrecta.
Billingsella exporrecta rugosicostata Walcott [1905a, p. 236]	Billingsella exporrecta rugosicostata.
Billingsella festinata Hall and Clarke [1892c, p. 230]	Nisusia festinata.
Billingsella harlanensis Walcott [1905a, p. 236]	Wimanella harlanensis.
Billingsella hicksi Walcott [1905a, p. 237]	Billingsella hicksi.
Billingsella highlandensis Walcott [1905a, pp. 237–238]	Billingsella highlandensis.
Billingsella lindstromi Walcott [1905a, pp. 238–239]	Billingsella lindströmi.
Billingsella major Walcott [1905a, p. 239]	Billingsella major.
Walcott [1908d, p. 101]	Do.
Billingsella marion Walcott [1908d, p. 102]	Billingsella marion.
Billingsella obscura Walcott [1905a, p. 239]	Billingsella obscura.
Billingsella orientalis Hall and Clarke [1892c, p. 230]	Billingsella orientalis.
Walcott [1905a, pp. 239–240]	Do.
Billingsella pepina Hall and Clarke [1892a, Pl. VIII, figs. 1 and 2]	Billingsella coloradoensis.
Hall and Clarke [1892c, p. 230]	Do.
(Billingsella) pepina [Orthis], Sardeson [1896, p. 96]	Do.
Billingsella plicatella Walcott [1905a, pp. 240–241]	Billingsella plicatella.
Billingsella pumpellyi Walcott [1905a, p. 242]	Billingsella pumpellyi.
Billingsella quacoensis Schuchert [1897, p. 159]	Protorthis quacoensis.
Billingsella retroflexa Matthew [1903, pp. 148–151]	Billingsella retroflexa.
Billingsella richthofeni Walcott [1905a, pp. 242–243]	Billingsella richthofeni.
Billingsella romingeri Walcott [1905a, pp. 243–244]	Billingsella romingeri.
Billingsella saffordi Walcott [1905a, p. 244]	Wimanella saffordi.
Billingsella salemensis Walcott [1905a, p. 245]	Billingsella salemensis.
Billingsella striata Walcott [1905a, p. 245]	Billingsella striata.
Billingsella whitfieldi Schuchert [1897, p. 159]	Billingsella whitfieldi.
Walcott [1905a, p. 246]	Do.
Billingsella (Otusia) Walcott [1905a, p. 246]	Otusia.
Billingsella (Otusia) sandbergi Walcott [1905a, pp. 246–247]	Otusia sandbergi.
billingsi [Billingsella], Schuchert [1897, p. 158]	Protorthis billingsi.
billingsi [Orthis], Hartt [1868, pp. 644–645]	Do.
Hartt [1878, pp. 644–645]	Do.
Hartt [1891, pp. 644–645]	Do.
Matthew [1886, p. 43]	Do.
Walcott [1884a, pp. 17–18]	Do.
billingsi [Orthis (Protorthis)], Wysogórski [1900, p. 227]	Do.
billingsi [Orthisina?], Matthew [1891, p. 131]	Do.
billingsi [Protorthis], Hall and Clarke [1892a, p. 274]	Do.
Hall and Clarke [1892c, pp. 219 and 232]	Do.
Walcott [1905a, pp. 281–282]	Do.
billingsi [Protorthis (Billingsella)], Grabau and Shimer [1907, p. 211]	Do.
billingsi [Syntrophia], Walcott [1905a, pp. 291–292]	Huenella billingsi.
Billingsia Ford [1886a, pp. 466–467]	Elkania.
de Koninck [1876]	Does not equal Elkania.
Walcott [1886, pp. 5, 21, 60, and 62]	A genus of the Gastropoda.
Billingsia? ambigua Ford [1886a, p. 467]	Elkania ambigua.
Billingsia desiderata Ford [1886a, pp. 466 and 467]	Elkania desiderata.
Billingsia? ida Ford [1886a, p. 467]	Elkania ida.
Billingsia pretiosa Ford [1886a, p. 467]	Acrothele pretiosa.
billingsiana [Lingula], Whiteaves [1878, p. 226]	Lingulella billingsiana.
billingsiana [Lingula cf.], Matthew [1894, p. 93]	Lingulella grandis.
bisecta [Acrotreta], Matthew [1901a, pp. 275–276]	Acrotreta bisecta.
Matthew [1902b, p. 394]	Do.
Matthew [1903, pp. 186–187]	Do.

	Present reference.
bisecta [Acrotreta], Walcott [1902, p. 582]	Acrotreta bisecta.
Walcott [1905a, pp. 298–299]	Do.
bivia [Billingsella], Walcott [new]	Billingsella bivia.
blackwelderi [Obolus (Westonia)], Walcott [1905a, p. 335]	Obolus (Westonia) blackwelderi.
bohemica [Acrothele], Hall and Clarke [1892c, p. 101]	Acrothele bohemica.
Pompeckj [1896b, pp. 509–511]	Do.
Walcott [1886b, p. 107]	Do.
bohemicus [Obolus?], Barrande [1879b, Pl. CII, figs. VII: 1–3]	Do.
borgholmensis [Acrothele], Walcott [1908d, pp. 84–85]	Acrothele borgholmensis.
bornemanni [Obolus (Lingulella)], Walcott [1901, pp. 687–688]	Lingulella bornemanni.
Botsfordia Walcott [1908e, Pl. XI, and pp. 142 and 145]	Botsfordia.
(Botsfordia) [Obolus], Matthew [1891, p. 148]	Do.
Matthew [1892, p. 63]	Do.
Botsfordia? barrandei Walcott [1908d, pp. 77–78]	Botsfordia? barrandei.
(Botsfordia) pulcher [Obolus], Matthew [1891, p. 148]	Botsfordia pulchra.
Matthew [1892, pp. 62–63]	Do.
Matthew [1902c, p. 95]	Do.
(Botsfordia) pulchra [Obolus], Matthew [1894, pp. 90–91]	Do.
Matthew [1895a, pp. 115–121]	Do.
bottnica [Lingula], Wiman [1902, p. 51]	Obolus (Westonia) bottnicus.
bottnica [Obolus (Westonia)], Walcott [1905a, pp. 335–336]	Do.
Brachiopode nouv. gen. de Verneuil and Barrande [1860, pp. 536–537]	Botsfordia? barrandei.
bretonensis [Obolus], Matthew [1902c, p. 95]	Obolus (Palæobolus) bretonensis.
bretonensis [Palæobolus], Matthew [1899c, p. 202]	Do.
Matthew [1903, pp. 141–143]	Do.
broadheadi [Linnarssonella], Walcott [1902, p. 601]	Linnarssonella girtyi.
(Bröggeria) [Obolus], Walcott [1902, p. 605]	Obolus (Bröggeria).
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
(Bröggeria) salteri [Obolus], Moberg and Segerberg [1906, p. 64]	Obolus (Bröggeria) salteri.
Walcott [1902, pp. 605–606]	Do.
(Bröggeria) salteri var.? [Obolus], Westergård [1909, p. 56]	Do.
bryograptorum [Lingula?], Moberg and Segerberg [1906, p. 63]	Lingulella lepis.
Westergård [1909, p. 57]	Do.
buchi [Keyserlingia], Hall and Clarke [1892c, p. 118]	Keyserlingia buchi.
Pander [1861, columns 46–48]	Do.
buchi [Orbicella], Hall and Clarke [1892a, p. 254]	Do.
d'Orbigny [1850, p. 20]	Keyserlingia buchi (in part).
buchi [Orbicula], de Verneuil [1845, pp. 288–289]	Keyserlingia buchi.
buchii [Discina], Eichwald [1860, p. 914]	Helmersenia ladogensis (in part) and Keyserlingia buchi (in part).
buttsi [Lingulella], Walcott [1908d, pp. 70–71]	Lingulella buttsi.

C.

cælata [Lingulella], Ford [1878, pp. 127–128]	Botsfordia cælata.
Hall and Clarke [1892a, Pl. III, figs. 1–4]	Do.
Hall and Clarke [1892c, pp. 57 and 58]	Do.
Walcott [1886b, p. 95]	Do.
Walcott [1887, p. 199, Pl. I, fig. 16]	Do.
Walcott [1891a, p. 607]	Do.
cælata [Obolella], Billings [1872a, p. 218]	Do.
cælata [Obolella (Orbicula)], Ford [1871, p. 33]	Do.
cælata [Orbicula], Hall [1847, p. 290]	Do.
calceoloides [Obolella wirrialpensis], Etheridge [1905, p. 249]	Obolella wirrialpensis.
calcifera [Camarella], Billings [1863, figs. 247a–c, p. 231]	Syntrophia calcifera.
calcifera [Camerella], Billings [1861a, pp. 318–320]	Do.
Billings [1865a, p. 220]	Do.
Meek [1873, p. 464]	Huenella abnormis.
calcifera [Syntrophia], Grabau and Shimer [1907, p. 271]	Syntrophia nundina.
calcifera [Syntrophia?], Hall and Clarke [1893b, p. 218]	Syntrophia calcifera.
calcifera [Triplecia?], Hall and Clarke [1892c, p. 270]	Do.
calcifera [Triplesia], Walcott [1884b, pp. 75–76]	Syntrophia nundina.
Camarella? antiquata Hall and Clarke [1893b, pp. 220–221]	Swantonia antiquata.
Camarella antiquata Walcott [1886b, pp. 122–123]	Do.
Walcott [1891a, p. 613]	Do.

	Present reference.
Camarella calcifera Billings [1863, figs. 247a–c, p. 231]	Syntrophia calcifera.
Camarella minor Hall and Clarke [1893b, p. 221]	Obolella minor.
Camarella? minor Walcott [1891a, p. 614]	Do.
cambria [Schuchertina], Walcott [1905a, pp. 323–324]	Schuchertina cambria.
cambria [Syntrophia], Walcott [1908d, pp. 106–107]	Syntrophia cambria.
Camerella antiquata Billings [1861b, pp. 10–11]	Swantonia antiquata.
Billings [1861c, p. 949]	Do.
Billings [1862e, p. 221]	Do.
Billings [1863, fig. 290, p. 284]	Do.
Camerella calcifera Billings [1861a, pp. 318–320]	Syntrophia calcifera.
Billings [1865a, p. 220]	Do.
Meek [1873, p. 464]	Huenella abnormis.
Camerella minor Walcott [1890b, pp. 36–37]	Obolella minor.
Camerella sp.? Shumard [1861, p. 221]	Huenella texana.
campbelli [Syntrophia], Walcott [1908d, pp. 107–108]	Syntrophia campbelli.
cancellata [Acrotreta?], Walcott [1905a, p. 299]	Acrotreta?? cancellata.
canius [Obolus (Lingulella)], Walcott [1902, pp. 610–611]	Lingulella cania.
carinata [Acrotreta], Moberg and Segerberg [1906, p. 66]	Acrotreta carinata.
Causea Wiman [1902, pp. 53–54]	Mickwitzia.
Causea formosa Wiman [1902, pp. 53–54]	Mickwitzia formosa.
cedens [Lingula], Barrande [1868a, p. 102]	Lingulella cedens.
Barrande [1868b, pp. 691–692]	Do.
celata [Schmidtia], Hall and Clarke [1892a, p. 244]	Obolus (Schmidtia) celatus.
Hall and Clarke [1892b, p. 560]	Do.
Hall and Clarke [1892c, p. 83]	Do.
Volborth [1869, pp. 209–212]	Do.
celatus [Obolus (Lingulella)], Walcott [1898b, Pl. XXVI, figs. 1 and 2]	Do.
celatus [Obolus (Schmidtia)], Mickwitz [1896, pp. 159–163]	Do
celatus orbiculatus [Obolus], Moberg and Segerberg [1906, p. 65]	Do
Westergård [1909, p. 56]	Do.
Wiman [1902, p. 62]	Do.
celatus orbiculatus [Obolus (Schmidtia)], Mickwitz [1896, pp. 163–165]	Do.
celatus præcisus [Obolus (Schmidtia)], Mickwitz [1896, pp. 166–167]	Do.
ceratopygarum [Acrothele], Moberg and Segerberg [1906, p. 67]	Acrothele ceratopygarum.
ceratopygarum [Discina (Acrotreta?)], Brögger [1882, p. 47]	Do.
ceratopygonum [Acrothele], Walcott [1902, p. 598]	Do.
chinensis [Obolus (Lingulella)], Walcott [1905a, pp. 328–329]	Obolus chinensis.
christianiæ [Orthis], Brögger [1882, p. 48]	Eoorthis christianiæ (in part) and E. daunus (in part).
Gagel [1890, pp. 10 and 34]	Eoorthis daunus.
Kjerulf [1865, pp. 1 and 3]	Eoorthis christianiæ.
Pompeckj [1902, p. 7]	Eoorthis daunus.
Remelé [1881, p. 69]	Do.
Remelé [1885, p. 6]	Do.
Roemer [1885, pp. 36, 37, and 38]	Do.
christianiæ [Orthis (Plectorthis)], Moberg and Segerberg [1906, p. 69]	Eoorthis christianiæ (in part only). The reference includes also E. daunus and E. tullbergi.
Walcott [1905a, pp. 260–261]	Eoorthis christianiæ.
chromatica [Obolella], Billings [1861b, pp. 7–8]	Obolella chromatica.
Billings [1861c, p. 947]	Do.
Billings [1862e, p. 219]	Do.
Billings [1863, p. 284]	Do.
Billings [1876, pp. 176–178]	Do.
Ford [1881, p. 133]	Do.
Hall [1863, p. 132]	Do.
Hall [1867, p. 110]	Do.
Hall and Clarke [1892c, p. 67]	Do.
von Toll [1899, p. 27]	(?) (See p. 592.)
Walcott [1885a, pp. 115 and 117]	Obolella crassa.
Walcott [1886b, p. 112]	Obolella chromatica.
Walcott [1891a, p. 611]	Do.
Walcott [1899, p. 446]	Do.
Walcott [1905a, p. 313]	Do.

	Present reference.
chuarensis [Obolus (Lingulella)], Walcott [1898b, p. 399]	Obolus (Westonia) chuarensis.
chuarensis [Obolus (Westonia)], Walcott [1901, p. 691]	Do.
cingulata [Kutorgina], Beecher [1891, pp. 345–346]	Kutorgina cingulata.
Bornemann [1891, p. 440]	Kutorgina sardiniaensis.
Davidson [1868, p. 312]	Micromitra (Paterina) phillipsi.
Davidson [1871, pp. 342–343]	Do.
Davidson [1883, p. 212]	Do.
Frech [1897, Pl. IA, figs. 6a–b]	Kutorgina cingulata.
Grabau and Shimer [1907, p. 209]	Do.
Hall and Clarke [1892a, Pl. IV, figs. 11–13]	Do.
Hall and Clarke [1892c, p. 92]	Do.
von Toll [1899, pp. 26–27]	Do.
Walcott [1886b, pp. 102–104]	Micromitra pusilla (in part), Micromitra (Paterina) phillipsi (in part), and Kutorgina cingulata (in part).
Walcott [1886b, pp. 102–104, Pl. IX, figs. 1–f]	Kutorgina cingulata.
Walcott [1886b, p. 103, Pl. IX, figs. 1g–h]	Rustella edsoni.
Walcott [1891a, p. 609, Pl. LXIX, figs. 1, 1a–f]	Kutorgina cingulata.
Walcott [1891a, p. 609, Pl. LXIX, figs. 1g–h]	Rustella edsoni.
Walcott [1905a, pp. 308–309]	Kutorgina cingulata.
cingulata [Obolella], Billings [1863, p. 284, figs. 287a–b]	Do.
Billings [1863, p. 284, fig. 287c]	Rustella edsoni.
cingulata [Obolella (Kutorgina)], Billings [1861b, pp. 8–9, figs. 8 and 10]	Kutorgina cingulata.
Billings [1861b, p. 8, fig. 9]	Rustella edsoni.
Billings [1861c, p. 948, figs. 347 and 349]	Kutorgina cingulata.
Billings [1861c, p. 948, fig. 348]	Rustella edsoni.
Billings [1862e, p. 220, figs. 347 and 349]	Kutorgina cingulata.
Billings [1862e, p. 220, fig. 348]	Rustella edsoni.
cingulata phillipsi [Kutorgina], Matley [1902, pp. 145–147]	Micromitra (Paterina) phillipsi.
cingulata pusilla [Kutorgina], Grönwall [1902, pp. 40–41]	Micromitra pusilla.
Linnarsson [1876, p. 25]	Do.
Matley [1902, pp. 146–147]	Do.
circe [Billingsella], Walcott [1901, p. 673]	Quebecia circe.
circe [Obolella], Billings [1872a, pp. 219–220]	Do.
Billings [1872c, pp. 357–358]	Do.
Walcott [1886b, p. 118, Pl. X, fig. 3]	Obolella chromatica. The text includes Quebecia circe.
Walcott [1886b, p. 118, Pl. X, fig. 3a]	Quebecia circe.
Walcott [1891a, p. 611, Pl. LXXI, fig. 3]	Obolella chromatica. The text includes Quebecia circe.
Walcott [1891a, p. 611, Pl. LXXI, fig. 3a]	Quebecia circe.
circe? [Obolella], Walcott [1891a, fig. 62, p. 611]	Obolella crassa.
circe [Quebecia], Walcott [1905a, pp. 320–321]	Quebecia circe.
circularis [Acrotreta], Moberg and Segerberg [1906, pp. 65–66]	Acrotreta circularis.
clarkei [Lingulella], Walcott [new]	Lingulella clarkei.
Clarkella Walcott [1908d, pp. 110–111]	Clarkella.
Walcott [1908e, Pl. XI, and pp. 142 and 148]	Do.
clarki [Dearbornia], Walcott [1908d, pp. 78–80]	Dearbornia clarki.
claytoni [Acrotreta], Walcott [1902, p. 583]	Acrotreta claytoni.
Clitambonites planus retroflexus Schuchert [1897, p. 184]	Billingsella retroflexa.
Clitambonites (Gonambonites) plana retroflexa Matthew [1895b, p. 267]	Do.
cœlata [Lingulella?], Matthew [1895a, p. 126]	Botsfordia cælata.
colleni [Acrothele], Walcott [new]	Acrothele colleni.
collicia [Leptobolus?], Matthew [1899b, p. 200]	Lingulella collicia.
collicia [Leptobolus], Matthew [1903, pp. 112–113]	Do.
collicia [Obolus (Lingulella)], Walcott [1902, p. 610]	Do.
collicia collis [Leptobolus], Matthew [1903, pp. 114–115]	Do.
collis [Leptobolus collicia], Matthew [1903, pp. 114–115]	Do.
coloradoensis [Billingsella], Grabau and Shimer [1907, p. 210]	Billingsella coloradoensis.
Schuchert [1897, p. 158]	Do.
Walcott [1899, pp. 450–451]	Do.
Walcott [1905a, pp. 231–234]	Do.

	Present reference.
coloradoensis [Orthis], Meek [1870, p. 425]	Eoorthis desmopleura.
Shumard [1860, p. 627]	Billingsella coloradoensis.
columbiana [Crania?], von Huene [1899a, p. 141]	Philhedra columbiana.
columbiana [Crania], Matthew [1902c, pp. 108–109]	Do.
columbiana [Crania?], Walcott [1889c, p. 441]	Do.
columbiana [Philhedra?], von Huene [1899b, pp. 216 and 298]	Do.
columbiana [Philhedra], Walcott [1908c, Pl. I, figs. 5 and 5a]	Do.
complexus [Obolella??], Hall and Clarke [1892c, p. 73]	Obolus complexus.
complexus [Obolus?], Barrande [1879b, Pls. XCV, CXI, CXIII, and CLII].	Do.
complexus [Schmidtia??], Mickwitz [1896, pp. 19–20]	Do.
compta [Orthisina], Tate [1892, p. 185]	Nisusia compta.
concentrica [Acrotreta], Walcott [1902, p. 583]	Acrotreta concentrica.
concinna [Lingulella], Matthew [1901a, pp. 273–274]	Lingulella concinna.
Matthew [1903, pp. 203–204]	Do.
concinnus [Obolus (Lingulella)], Walcott [1902, pp. 608–609]	Do.
contraria [Discina], Barrande [1868a, p. 104]	Orbiculoidea contraria.
Barrande [1868b, pp. 692–693]	Do.
Pompeckj [1896a, p. 4]	Do.
conula [Acrotreta], Walcott [1902, p. 584]	Acrotreta conula.
convexa [Acrotreta], Walcott [1902, p. 584]	Acrotreta convexa.
convexa [Ungula], Pander [1830, pp. 59 and 163]	Obolus apollinis quenstedti.
convexa [Ungula plana or], Pander [1830, p. 163]	Obolus apollinis.
convexus [Obolus (Lingulella) winona], Walcott [1901, p. 691]	Lingulella winona convexa.
coriace [Acrothele], Brögger [1878, p. 76]	Acrothele coriacea.
coriacea [Acrothele], Grönwall [1902, p. 40]	Do.
Linnarsson [1876, pp. 21–23]	Do.
corrugata [Lingula?], Moberg and Segerberg [1906, p. 63]	Lingulella lepis.
Westergård [1909, p. 57]	Do.
corrugata [Orthis (Finkelnburgia) osceola], Walcott [1905a, p. 280]	Finkelnburgia osceola corrugata.
costata [Acrothele matthewi], Matthew [1895a, p. 128]	Acrothele prima costata.
Matthew [1902b, p. 399]	Do.
Matthew [1903, p. 104]	Do.
Crania Eichwald [1829, p. 273]	Siphonotreta (in part).
Crania? columbiana von Huene [1899a, p. 141]	Philhedra columbiana.
Crania columbiana Matthew [1902c, pp. 108–109]	Do.
Crania? columbiana Walcott [1889c, p. 441]	Do.
Crania sulcata Eichwald [1829, p. 274]	Siphonotreta unguiculata.
Crania unguiculata Eichwald [1829, p. 274]	Do.
Craniella?? sp. Walcott [1905b, pp. 4 and 6]	Discinopsis? sulcatus.
crassa [Acrothyra proavia], Matthew [1902b, pp. 389–390]	Acrothyra proavia.
Matthew [1903, p. 94]	Do.
crassa [Dicellomus], Hall [1873, p. 246]	Obolella crassa.
crassa [Obolella], Billings [1872a, p. 218]	Do.
Billings [1872c, p. 356]	Do.
Bornemann [1891, pp. 439–440]	Obolus? zoppi.
Ford [1878, p. 128]	Obolella crassa.
Ford [1881, pp. 131–133]	Do.
Ford [1886a, fig. 2, p. 466]	Do.
Gorham [1905, Pl. I, figs. 1a–f]	Obolella atlantica.
Grabau and Shimer [1907, pp. 188–189]	Obolella crassa.
Hall and Clarke [1892a, Pl. III, figs. 5–7]	Do.
Hall and Clarke [1892c, p. 70]	Do.
Shaler and Foerste [1888, p. 27]	Obolella atlantica.
Walcott [1885b, p. 21]	Obolella crassa.
Walcott [1886b, p. 114]	Do.
Walcott [1891a, p. 612]	Do.
Walcott [1905a, p. 321]	Do.
crassa? [Obolella], Grabau [1900, pp. 619–620]	Do.
crassa [Obolella (Orbicula?)], Ford [1871, p. 33]	Do.
crassa [Orbicula?], Hall [1847, p. 290]	Do.
crassa elongata [Obolella], Walcott [new]	Obolella crassa elongata.
crassus [Obolus (Schmidtia)], Mickwitz [1896, pp. 187–193]	Obolus (Schmidtia) crassus.
crassus angulatus [Obolus (Schmidtia)], Mickwitz [1896, pp. 193–194]	Do.

	Present reference.
crenistria [Iphidea], Walcott [1897b, p. 713]	Micromitra (Paterina) crenistria.
cuneata [Lingulella?], Matthew [1894, pp. 92–93]	Lingulella grandis.
cuneata [Lingulobolus affinis], Matthew [1895b, p. 262]	Obolus (Lingulobolus) affinis.
cuneolus [Lingulepis], Schuchert [1897, p. 259]	Lingulella perattenuata (in part).
Whitfield [1877, pp. 8–9]	Lingulella cuneola.
Whitfield [1880, p. 336]	Do.
cuneolus [Obolus (Lingulella)], Walcott [1899, p. 443]	Do.
Curticia Walcott [1905a, p. 319]	Curticia.
Walcott [1908e, Pl. XI and pp. 142 and 143]	Do.
Curticia elegantula Walcott [1905a, pp. 319–320]	Curticia elegantula.
curvata [Acrotreta], Walcott [1902, p. 584]	Acrotreta curvata.
cyane [Glossina], Schuchert [1897, p. 224]	Obolus cyane.
cyane [Lingula], Billings [1865a, p. 216]	Do.

D.

dakotensis [Lingula], Meek and Hayden [1865, p. 3]	Lingulella (Lingulepis) acuminata.
Whitfield [1880, pp. 337–338]	Do.
Dalmanella melita Schuchert [1897, p. 202]	Variety of Eoorthis desmopleura.
damesi [Obolus (Lingulella)], Walcott [1905a, p. 329]	Obolus damesi. (See Lingulella damesi, p. 489.)
dartoni [Obolus (Westonia)], Walcott [1908d, p. 67]	Obolus (Westonia) dartoni.
daunus [Orthis (Plectorthis)], Moberg and Segerberg [1906, p. 69]	Eoorthis daunus.
Walcott [1905a, p. 261]	Do.
Davidsonella Munier-Chalmas [1880]	Davidsonella, not Neobolus.
Waagen [1885a, pp. 762–764]	Neobolus.
Davidsonella linguloides Waagen [1885a, pp. 764–766]	Neobolus warthi.
Davidsonella squama Waagen [1885a, pp. 766–767]	Do.
davidsoni [Lingula], Barrande [1879b, Pl. CIV, figs. VIII: 1–4]	Lingulella davidsoni.
davisi [Lingula], McCoy [1851b, pp. 405–406]	Lingulella davisi.
McCoy [1854, p. 252]	Do.
davisi [Lingula cf.], Schmidt [1881, p. 17, fig. 5]	Obolus (Mickwitzella) siluricus.
davisi [Lingulella], Davidson [1868, pp. 304 and 306]	Lingulella davisi.
Hall and Clarke [1892a, p. 232]	Do.
Hall and Clarke [1892b, p. 548]	Do.
Hall and Clarke [1892c, pp. 56 and 57]	Do.
Meek [1871, pp. 186–187]	Do.
Salter [1866b, pp. 333–334]	Do.
davisii [Lingulella], Davidson [1866, pp. 56 and 57]	Do.
Hall [1873, Pl. XIII, fig. 4]	Do.
Roemer [1876, Pl. II, figs. 5a–c]	Do.
Salter [1867, pp. 44 and 52]	Do.
Salter and Etheridge [1881, pp. 537–538]	Do.
davisii [Lingulella cf.], Kayser [1897, p. 280]	Do.
Matthew [1902b, pp. 407–408]	Do.
Matthew [1903, p. 203]	Do.
davisii [Obolus (Lingulella)], Walcott [1898b, pp. 394 and 395]	Do.
dawsoni [Lingula?], Matthew MS. [1884]	Lingulella ferruginea.
Walcott [1884a, p. 15]	Do.
dawsoni [Lingulella], Hall and Clarke [1892c, p. 58]	Do.
Matthew [1886, pp. 33–34, Pl. V, figs. 9, 9a–c]	Liugulella martinensis. The text includes L. ferruginea.
Matthew [1886, pp. 33–34, Pl. V, fig. 9d]	Lingulella ferruginea. The text includes L. martinensis.
Dearbornia Walcott [1908d, p. 78]	Dearbornia.
Walcott [1908e, Pl. XI, and pp. 142 and 146]	Do.
Dearbornia clarki Walcott [1908d, pp. 78–80]	Dearbornia clarki.
decipiens [Acrothele], Walcott [1897b, p. 716]	Acrothele decipiens.
decipiens [Obolus mcconnelli], Walcott [new]	Obolus mcconnelli decipiens.
definita [Acrotreta], Walcott [1902, pp. 584–585]	Acrotreta definita.
Delgadella Walcott [1908e, Pl. XI, and pp. 142 and 144]	Delgadella.
delgadoi [Lingulella], Walcott [new]	Lingulella delgadoi.
depressa [Acrotreta], Walcott [1908c, p. 245]	Acrotreta depressa.
depressa [Acrotreta gemma], Matthew [1902c, p. 109]	Do.
Walcott [1889c, pp. 441–442]	Do.

	Present reference.
descendens [Acrotreta ophirensis], Walcott [1908d, p. 95]	Acrotreta ophirensis descendens.
desiderata [Billingsia], Ford [1886a, pp. 466 and 467]	Elkania desiderata.
desiderata [Elkania], Ford [1886b, p. 325]	Do.
Hall and Clarke [1892a, Pl. III, figs. 13 and 14]	Do.
Hall and Clarke [1892c, pp. 76 and 77]	Do.
desiderata [Obolella], Billings [1862d, pp. 69–70]	Do.
Davidson [1868, p. 309]	Do.
desiderata [Obolella?], Walcott [1886b, p. 111]	Do.
desideratus [Obolus (Lingulella)], Walcott [1898b, pp. 399–400]	Lingulella desiderata.
Walcott [1899, pp. 445–446, Pl. LX, fig. 2]	Do.
Walcott [1899, pp. 445–446, Pl. LX, fig. 2a]	Obolus rotundatus.
desmopleura [Orthis], Meek [1872, p. 295]	Eoorthis desmopleura.
desmopleura [Orthis (Plectorthis)], Walcott [1905a, p. 261]	Do.
desmopleura nympha [Orthis (Plectorthis)], Walcott [1905a, p. 262]	Eoorthis desmopleura nympha.
desquamata [Avicula?], Hall [1847, p. 292]	Obolella crassa.
desquamata [Obolella], Billings [1872a, p. 218]	Do.
Billings [1872c, p. 356]	Do.
diablo [Orthis (Plectorthis)], Walcott [1905a, p. 262]	Eoorthis? diablo.
dice [Billingsella], Walcott [1905a, p. 234]	Billingsella dice.
Dicellomus Grabau and Shimer [1907, p. 189]	Dicellomus.
Hall [1873, p. 246]	Do.
Hall and Clarke [1892a, pp. 240–241]	Do.
Hall and Clarke [1892c, pp. 66–73]	Do.
Walcott [1899, p. 446]	Do.
Walcott [1905a, pp. 312–313]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
Dicellomus appalachia Walcott [1905a, p. 314]	Dicellomus appalachia.
Dicellomus crassa Hall [1873, p. 246]	Obolella crassa.
Dicellomus nanus Walcott [1899, p. 447]	Lingulella desiderata (in part) and Dicellomus nanus (in part).
Walcott [1905a, pp. 314–315]	Dicellomus nanus.
Dicellomus parvus Walcott [1905a, pp. 315–316]	Dicellomus parvus.
Dicellomus pectenoides Walcott [1901, p. 673]	Dicellomus pectenoides.
Walcott [1905a, p. 316]	Do.
Dicellomus polita Hall [1873, p. 246]	Dicellomus politus.
Dicellomus politus Grabau and Shimer [1907, pp. 189–190]	Do.
Walcott [1899, pp. 443 and 446]	Do.
Walcott [1905a, pp. 313 and 316–318]	Do.
Dicellomus prolificus Walcott [1908d, p. 77]	Dicellomus prolificus.
Dicellomus sp. undt. Walcott [1905a, p. 319]	Dicellomus sp. undt.
dichotoma [Acrothele?], Walcott [1884b, pp. 14–15]	Acrothele dichotoma.
dichotoma [Acrotreta], Hall and Clarke [1892c, pp. 100 and 103]	Do.
Walcott [1886b, p. 107]	Do.
Discina buchii Eichwald [1860, p. 914]	Helmersenia ladogensis (in part) and Keyserlingia buchi (in part).
Discina contraria Barrande [1868a, p. 104]	Orbiculoidea coutraria.
Barrande [1868b, pp. 692–693]	Do.
Pompeckj [1896a, p. 4]	Do.
Discina labiosa Salter [1866a, p. 285]	Acrotreta sagittalis.
Discina microscopica Shumard [1861, p. 221]	Acrotreta microscopica.
Discina pileolus Davidson [1868, pp. 312–313]	Orbiculoidea pileolus.
Davidson [1871, p. 344]	Do.
(Hicks MS.) Salter [1866a, p. 285]	Do.
Discina pileolus? Hicks [1871, Pl. XV, figs. 12 and 12a]	Stenotheca pileolus, a gastropod.
Discina varians Barrande [1868a, pp. 103–104]	Orbiculoidea varians.
Barrande [1868b, p. 692]	Do.
Pompeckj [1896a, p. 4]	Do.
Discina sp. Miquel [1893, p. 9]	Acrothele bergeroni.
Miquel [1894a, p. 106]	Do.
Miquel [1894b, p. 10]	Do.
Miquel [1895, p. 10]	Do.

	Present reference.
Discina? sp. Kjerulf [1873, p. 83, figs. 12 and 13]	Obolella (Glyptias) favosa?.
Discina (Acrotreta?) ceratopygarum Brögger [1882, p. 47]	Acrothele ceratopygarum.
Discina (Orbicula) primæva de Verneuil and Barrande [1860, p. 532]	Acrothele primæva.
Discinolepis Hall and Clarke [1892a, p. 247]	Discinolepis.
Hall and Clarke [1892b, p. 563]	Do.
Hall and Clarke [1892c, p. 90]	Do.
Waagen [1885a, pp. 749–750]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 146]	Do.
Discinolepis granulata Hall and Clarke [1892a, p. 247]	Discinolepis granulata.
Hall and Clarke [1892b, p. 563]	Do.
Hall and Clarke [1892c, p. 90]	Do.
Waagen [1885a, pp. 750–751]	Do.
Waagen [1891, Pl. II, figs. 15 and 16]	Do.
Discinopsis Hall and Clarke [1892a, pp. 250–251]	Discinopsis.
Hall and Clarke [1892b, pp. 566–567]	Do.
Hall and Clarke [1892c, pp. 105–106]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 146]	Do.
Discinopsis gulielmi Hall and Clarke [1892a, Pl. III, figs. 20 and 21]	Discinopsis gulielmi.
Hall and Clarke [1892c, p. 105]	Do.
Discinopsis sulcatus Walcott [1906, pp. 568–569]	Discinopsis? sulcatus.
discoida [Obolella], Hall and Whitfield [1877, p. 205]	Obolus discoideus.
discoidea [Obolella?], Hall and Clarke [1892c, p. 69]	Do.
discoidea [Obolella], Walcott [1884b, p. 14]	Do.
discoidea [Obolella?], Walcott [1886b, p. 111]	Do.
discoideus [Obolus (Lingulella)], Walcott [1901, p. 673]	Do.
discus [Obolus], Matthew [1902c, p. 94]	Lingulella triparilis.
discus [Obolus (Eobolus)], Matthew [1903, pp. 138–139]	Do.
dolata [Lingula], Sardeson [1896, p. 95]	Obolus dolatus.
doris [Orthis (Plectorthis)], Walcott [1905a, pp. 262–263]	Eoorthis doris.
dougaldensis [Protorthis (Loperia)], Walcott [1905a, pp. 287–288]	Protorthis (Loperia) dugaldensis.
dubia [Siphonotreta?], Walcott [new]	Siphonotreta dubia.
dubius [Obolus (Lingulella)], Walcott [1898b, p. 401]	Lingulella dubia.
edsoni [Rustella], Walcott [1905a, pp. 311–312]	Rustella edsoni.
eggegrundensis [Acrotreta], Walcott [1905a, pp. 299–300]	Acrotreta eggegrundensis.
Wiman [1902, p. 55]	Do.
eichwaldi [Obolus], Mickwitz [1896, pp. 154–155]	Obolus eichwaldi.
elegans [Obolus], Mickwitz [1896, pp. 157–158]	Obolus elegans.
elegantula [Curticia], Walcott [1905a, pp. 319–320]	Curticia elegantula.
elegantula [Strophomena (Eostrophomena)], Walcott [1905a, pp. 256–257]	Eostrophomena elegantula.
Elkania Ford [1886b, p. 325]	Elkania.
Hall and Clarke [1892a, p. 241]	Do.
Hall and Clarke [1892b, p. 557]	Do.
Hall and Clarke [1892c, pp. 75–78]	Do.
Walcott [1905a, pp. 321–323]	Elkania (in part) and Obolus (Fordinia) (in part).
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Elkania.
Elkania ambigua Ford [1886b, p. 325]	Elkania ambigua.
Hall and Clarke [1892c, p. 78]	Do.
Elkania bellula Walcott [1905a, p. 323]	Obolus (Fordinia) bellulus.
Elkania desiderata Ford [1886b, p. 325]	Elkania desiderata.
Hall and Clarke [1892a, Pl. III, figs. 13 and 14]	Do.
Hall and Clarke [1892c, pp. 76 and 77]	Do.
Elkania ida Ford [1886b, p. 325]	Elkania ida.
Elkania pretiosa Ford [1886b, p. 325]	Acrothele pretiosa.
ella [Lingulella], Hall and Clarke [1892c, p. 58, figs. 19 and 21]	Obolus (Westonia) ella. The text includes also specimens representing Lingulella dubia.
Hall and Clarke [1892c, p. 58, fig. 20]	Lingulella dubia.
Pack [1906, p. 295]	Obolus (Westonia) ella.
Walcott [1886b, pp. 97–98, Pl. VII, fig. 2; Pl. VIII, figs. 4, 4a, 4d–e]	Obolus (Westonia) ella. The text includes also specimens representing Lingulella dubia.

	Present reference.
ella [Lingulella], Walcott [1886b, pp. 97–98, Pl. VIII, figs. 4b and 4c]	Lingulella dubia. The text includes Obolus (Westonia) ella.
Walcott [1891a, p. 607, Pl. LXVII, figs. 2, 2a–b, and 2e]	Obolus (Westonia) ella. The text includes also specimens representing Lingulella dubia.
Walcott [1891a, p. 607, Pl. LXVII, figs. 2c–d]	Lingulella dubia. The text includes Obolus (Westonia) ella.
ella [Lingulella (Westonia)], Grabau and Shimer [1907, p. 193]	Obolus (Westonia) ella.
ella [Lingulepis], Hall and Whitfield [1877, p. 232]	Do.
Walcott [1897a, p. 404]	Do.
ella [Obolus], Matthew [1902c, pp. 96 and 110]	Do.
ella [Obolus (Lingulella)], Walcott [1898b, Pl. XXVIII, figs. 5–8]	Do.
ella [Obolus (Westonia)], Walcott [1901, p. 691]	Do.
ella onaquiensis [Obolus (Westonia)], Walcott [1908d, pp. 67–68]	Obolus (Westonia) ella onaquiensis.
ellipticus [Obolus (Schmidtia) obtusus], Mickwitz [1896, pp. 177–178]	Obolus (Schmidtia) obtusus.
ellsi [Obolus (Lingulella)], Walcott [1898b, p. 402]	Lingulella ellsi.
elongata [Obolella crassa], Walcott [new]	Obolella crassa elongata.
elongatus [Obolus (Westonia)], Walcott [1908d, p. 68]	Obolus (Westonia) elongatus.
emmonsi [Acrotreta], Walcott [1905a, p. 300]	Acrotreta emmonsi.
endlichi [Micromitra sculptilis], Walcott [1908d, p. 56]	Micromitra sculptilis endlichi.
Eoobolus Matthew [1902c, p. 97]	Lingulella.
(Eoobolus) [Obolus], Matthew [1903, pp. 135–136]	Obolus (in part) and Lingulella (in part).
(Eoobolus) discus [Obolus], Matthew [1903, pp. 138–139]	Lingulella triparilis.
(Eoobolus) triparilis [Obolus], Matthew [1903, pp. 136–137]	Do.
Eoorthis Walcott [1908d, pp. 102–104]	Eoorthis.
Walcott [1908e, Pl. XI, and pp. 142 and 148]	Do.
Eoorthis newberryi Walcott [1908d, p. 105]	Eoorthis newberryi.
Eoorthis thyone Walcott [1908d, pp. 105–106]	Eoorthis thyone.
Eoorthis zeno Walcott [1908d, p. 106]	Eoorthis zeno.
Eostrophomena Walcott [1908e, Pl. XI, and pp. 142 and 148]	Eostrophomena.
(Eostrophomena) [Strophomena], Walcott [1905a, p. 256]	Do.
(Eostrophomena) elegantula [Strophomena], Walcott [1905a, pp. 256–257]	Eostrophomena elegantula.
(Eostrophomena) walcotti [Strophomena], Moberg and Segerberg [1906, p. 71]	Do.
erecta [Nisusia (Jamesella)], Walcott [1905a, p. 253]	Nisusia (Jamesella) erecta.
eros [Obolus (Lingulepis)], Walcott [1905a, p. 333]	Lingulella (Lingulepis) eros.
eryx [Acrothele matthewi], Walcott [1905b, p. 11]	Acrothele matthewi eryx.
escasoni [Lingulella(?)], Matthew [1901a, pp. 270–273]	Obolus (Westonia) escasoni.
escasoni [Obolus (Westonia)], Walcott [1901, p. 691]	Do.
escasoni [Westonia], Matthew [1903, pp. 206–209]	Do.
esthonia [Schizambon ?], Walcott [new]	Schizambon ? esthonia.
etheridgei [Huenella], Walcott [1908d, pp. 109–110]	Huenella etheridgei.
etheridgei [Platyceras], Tate [1892, p. 184]	Micromitra (Paterina) etheridgei.
euglyphus [Obolus (Lingulella)], Walcott [1898b, pp. 402–403]	Obolus (Westonia) euglyphus.
euglyphus [Obolus (Westonia)], Walcott [1901, p. 691]	Do.
(Euobolus) [Obolus], Mickwitz [1896, pp. 129 and 133]	Lingulella (in part) and Obolus (in part).
eurekensis [Orthis?], Schuchert [1897, p. 286]	Orusia ? eurekensis.
eurekensis [Orthis], Walcott [1884b, pp. 22–23]	Do.
eurekensis [Orthis (Orusia?)], Walcott [1905a, p. 277]	Do.
eurekensis [Protorthis?], Hall and Clarke [1892c, p. 232]	Do.
excelsis [Trematobolus], Walcott [1908d, pp. 80–81]	Trematobolus excelsis.
exigua [Lingulepis starri], Matthew [1903, pp. 197–198]	Lingulella (Lingulepis) exigua.
exporecta [Orthis], Linnarsson [1876, pp. 12–13]	Do.
exporrecta [Billingsella], Walcott [1905a, pp. 234–236]	Billingsella exporrecta.
exporrecta [Orthis], Kayser [1883, p. 35]	Do.
Wallerius [1895, p. 66]	Do.
exporrecta rugosicostata [Billiugsella], Walcott [1905a, p. 236]	Billingsella exporrecta rugosicostata.
extenuatus [Obolus (Schmidtia) obtusus], Mickwitz [1896, pp. 178–179]	Obolus (Schmidtia) obtusus.
exungui [Lingula aff.], Gürich [1896, p. 214]	Lingulella siemiradzkii.
exunguis [Lingula cf.], Gürich [1892, p. 69]	Do.
Siemiradzki [1886, p. 672]	Do.

F.

Present reference

favosa [Lingula(?)], Linnarsson [1869a, pp. 356–357]..... Obolella (Glyptias) favosa.
Linnarsson [1869b, p. 406]..... Do.
favosa [Lingulella(?) cf. Lingula], Matthew [1888, pp. 28–29]..... Botsfordia pulchra.
favosa [Obolella (Glyptias)], Walcott [1901, pp. 675–676]..... Obolella (Glyptias) favosa.
feistmanteli [Lingula], Barrande [1879b, Pls. CVI and CX]..... Obolus feistmanteli.
ferruginea [Lingulella], Davidson [1868, pp. 306–307]..... Lingulella ferruginea.
Davidson [1871, pp. 336–337]..... Do.
Davidson [1883, Pl. XVII, fig. 35]..... Do.
Delgado [1904, pp. 368–369]..... Lingulella delgadoi.
Matthew [1903, p. 108]..... Lingulella ferruginea.
Salter [Salter and Hicks, 1867, p. 340]..... Do.
Salter and Etheridge [1881, p. 538]..... Do.
ferruginea [Lingulella cf.], Kayser [1897, p. 280]..... Do.
ferruginea ovalis [Lingulella], Davidson [1868, p. 307]..... Do.
Hicks [Salter and Hicks, 1867, p. 341]..... Do.
festinata [Billingsella], Hall and Clarke [1892c, p. 230]..... Nisusia festinata.
festinata [Nisusia], Grabau and Shimer [1907, p. 211]..... Do.
Walcott [1905a, pp. 249–251]..... Do.
festinata [Orthisina], Billings [1861b, p. 10]..... Do.
Billings [1861c, p. 949]..... Do.
Billings [1862b, p. 105]..... Do.
Billings [1862e, p. 221]..... Do.
Billings [1863, p. 284, figs. 289a–c]..... Do.
Walcott [1886b, pp. 120–121]..... Do.
Walcott [1891a, p. 613]..... Do.
festinata transversa [Nisusia], Walcott [1905a, p. 251]..... Nisusia festinata transversa.
finkelnburgi [Orthis (Finkelnburgia)], Walcott [1905a, pp. 278–279]..... Finkelnburgia finkelnburgi.
Finkelnburgia Walcott [1908e, Pl. XI, and pp. 142 and 148]..... Finkelnburgia.
(Finkelnburgia) [Orthis], Walcott [1905a, pp. 277–278]..... Do.
(Finkelnburgia) finkelnburgi [Orthis], Walcott [1905a, pp. 278–279]..... Finkelnburgia finkelnburgi.
(Finkelnburgia) osceola [Orthis], Walcott [1905a, p. 279]..... Finkelnburgia osceola.
(Finkelnburgia) osceola corrugata [Orthis], Walcott [1905a, p. 280]..... Finkelnburgia osceola corrugata.
finlandensis [Obolus (Westonia)], Walcott [1902, pp. 611–612]..... Obolus (Westonia) finlandensis.
flumenis [Leptobolus], Matthew [1903, pp. 189–190]..... Lingulella flumenis.
(Fordinia) [Obolus], Walcott [1908d, pp. 64–65]..... Obolus (Fordinia).
Walcott [1908e, Pl.XI, and pp. 142 and 144]..... Do.
(Fordinia) gilberti [Obolus], Walcott [1908d, p. 65]..... Obolus (Fordinia) gilberti.
(Fordinia) perfectus [Obolus], Walcott [1908d, pp. 65–66]..... Obolus (Fordinia) perfectus.
formosa [Causea], Wiman [1902, pp. 53–54]..... Mickwitzia formosa.
fragilis [Obolus (Lingulella)], Walcott [1898b, p. 404]..... Obolus fragilis.
franklinensis [Obolus (Lingulella)], Walcott [1898b, pp. 404–405]..... Lingulella franklinensis.
fuchsi [Lingulella], Redlich [1899, p. 7]..... Lingulella fuchsi.
fuchsi [Obolus (Lingulella)], Walcott [1905a, p. 332]..... Do.

G.

gamagei [Acrothele], Grabau [1900, pp. 615–617]..... Acrothele gamagei.
Grabau and Shimer [1907, p. 200]..... Do.
Shimer [1907, pp. 176 and 177]..... Do.
gamagei [Obolella], Hobbs [1899, pp. 114–115]..... Do.
gemma [Acrotreta], Billings [1865a, pp. 216–217]..... Acrotreta gemma.
Grabau and Shimer [1907, p. 199]..... Acrotreta primæva.
Hall and Clarke [1892c, p. 102, fig. 55]..... Acrotreta curvata.
Hall and Clarke [1892c, p. 102, figs. 56 and 57]..... Acrotreta idahoensis alta.
Walcott [1884b, pp. 17–18]..... Acrotreta attenuata (in part), A. pyxidicula (in part), A. curvata (in part), and A. idahoensis (in part). The text includes all four species, but the last two were the only ones figured.
Walcott [1884b, pp. 17–18, Pl. I, figs. 1a–b]..... Acrotreta idahoensis alta.
Walcott [1884b, pp. 17–18, Pl. I, figs. 1d–e]..... Acrotreta curvata.

	Present reference.
gemma [Acrotreta], Walcott [1886b, pp. 98–99]	Acrotreta attenuata (in part), A. pyxidicula (in part), and A. primæva (in part). The text includes all three species, but the last was the only one figured.
Walcott [1886b, pp. 98–99, Pl. VIII, figs. 1, 1a–b]	Acrotreta primæva.
Walcott [1891a, p. 608]	Acrotreta attenuata (in part), A. pyxidicula (in part), A. curvata (in part), A. idahoensis alta (in part), and A. primæva (in part). The text includes all five species, but the last three were the only ones figured.
Walcott [1891a, p. 608, Pl. LXVII, figs. 5 and 5a]	Acrotreta idahoensis alta.
Walcott [1891a, p. 608, Pl. LXVII, fig. 5b]	Acrotreta curvata.
Walcott [1891a, p. 608, Pl. LXVII, figs. 5c–e]	Acrotreta primæva.
Walcott [1899, p. 449]	Acrotreta attenuata (in part), A. pyxidicula (in part), A. curvata (in part), A. idahoensis alta (in part), and A. primæva (in part). The text includes all five species, but the last three were the only ones figured.
Walcott [1899, p. 449, Pl. LXII, figs. 2, 2b, and 2d]	Acrotreta primæva.
Walcott [1899, p. 449, Pl. LXII, figs. 2a and 2c]	Acrotreta idahoensis alta.
Walcott [1899, p. 449, Pl. LXII, fig. 2e]	Acrotreta curvata.
gemma [Bicia], Walcott [1901, pp. 678–680]	Bicia gemma.
gemma [Obolella], Billings [1872a, pp. 218–219]	Do.
Billings [1872c, p. 355]	Do.
Hall and Clarke [1892c, pp. 69 and 71]	Do.
Walcott [1886b, pp. 116–117]	Do.
Walcott [1891a, p. 612]	Do.
gemma depressa [Acrotreta], Matthew [1902c, p. 109]	Acrotreta depressa.
Walcott [1889c, pp. 441–442]	Do.
gemmula [Acrotreta], Matthew [1894, pp. 87–88]	Acrotreta gemmula.
Matthew [1895a, p. 126]	Do.
Matthew [1903, p. 97]	Do.
gemmula [Obolella?], Matthew [1892, pp. 41–42]	Lingulella ferruginea.
gemmulus [Leptobolus], Matthew [1903, pp. 190–192]	Do.
gemmulus [Obolus (Lingulella)], Walcott [1901, p. 673]	Do.
genei [Lingulella], Pack [1906, p. 295]	Lingulella dubia.
Genre? sp. nebulosa Barrande [1868a, pp. 105–106]	Orbiculoidea contraria.
Barrande [1868b, pp. 693–694]	Do.
gilberti [Obolus (Fordinia)], Walcott [1908d, p. 65]	Obolus (Fordinia) gilberti.
girtyi [Linnarssonella], Walcott [1902, pp. 602–603]	Linnarssonella girtyi.
Glossina acuminata Hall and Clarke [1892a, Pl. I, figs. 10 and 11]	Lingulella (Lingulepis) acuminata sequens.
(Glossina) acuminata [Lingula], Hall and Clarke [1892c, Pl. I, figs. 1 and 2]	Do.
Glossina cyane Schuchert [1897, p. 224]	Obolus cyane.
(Glyptias) [Obolella], Walcott [1901, p. 675]	Obolella (Glyptias).
Walcott [1908e, Pl. XI, and pp. 142 and 145]	Do.
(Glyptias) favosa [Obolella], Walcott [1901, pp. 675–676]	Obolella (Glyptias) favosa.
(Gonambonites) plana retroflexa [Clitambonites], Matthew [1895b, p. 267]	Billingsella retroflexa.
gracia [Acrotreta], Walcott [1902, pp. 586–587]	Acrotreta gracia.
grandis [Leptobolus], Matthew [1894, pp. 91–92]	Lingulella grandis.
grandis [Leptobolus cf.], Matthew [1902c, p. 111]	Does not equal Lingulella grandis. It is not referred in this monograph.
grandis [Lingulella lævis], Matthew [1903, pp. 200–201]	Lingulella lævis grandis.
granulata [Acrothele], Davidson [1883, p. 214]	Acrothele (Redlichella) granulata.
Hall and Clarke [1892c, pp. 100–101]	Do.
Linnarsson [1876, p. 24]	Do.
Linnarsson [1877, pp. 373–374]	Do.
Swanston [1877, Pl. VII, figs. 20a–c]	Do.
Swanston [1886, Pl. VII, figs. 20a–c]	Do.
Walcott [1886b, p. 109]	Do.

	Present reference.
granulata [Discinolepis], Hall and Clarke [1892a, p. 247]	Discinolepis granulata.
Hall and Clarke [1892b, p. 563]	Do.
Hall and Clarke [1892c, p. 90]	Do.
Waagen [1885a, pp. 750–751]	Do.
Waagen [1891, Pl. XI, figs. 15 and 16]	Do.
granulata [Kutorgina], Matthew [1899a, p. 189]	Kutorgina granulata.
Matthew [1899e, p. 98]	Do.
granulata [Mobergia], Redlich [1899, pp. 5–6]	Botsfordia granulata.
granvillensis [Lingulella], Delgado [1904, pp. 367–368]	Lingulella delgadoi.
Hall and Clarke [1892c, p. 58]	Lingulella granvillensis.
Oehlert [1889, p. 1138]	Do.
Walcott [1887, pp. 188–189]	Do.
Walcott [1891a, pp. 607–608]	Do.
granvillensis [Lingulella cf.], Matthew [1895a, pp. 114–115]	Lingulella martinensis.
gregwa [Lingulella], Matthew [1899b, pp. 199–200]	Lingulella (Lingulepis) gregwa.
gregwa [Lingulepis], Matthew [1903, pp. 56–57 and 126–131]	Do.
gregwa [Obolus (Lingulepis)], Walcott [1901, pp. 692–694]	Lingulella atava (in part), L. cania (in part), L. tumida (in part), Lingulella (Lingulepis) gregwa (in part), and L. (L.) exigua (in part).
gregwa robusta [Lingulepis], Matthew [1903, pp. 57 and 131]	Lingulella (Lingulepis) gregwa robusta.
groomi [Obolella], Matley [1902, pp. 137 and 139]	Obolella groomi.
gulielmi [Acrotreta?], Matthew [1886, pp. 37–39]	Discinopsis gulielmi.
gulielmi [Discinopsis], Hall and Clarke [1892a, Pl. III, figs. 20 and 21]	Do.
Hall and Clarke [1892c, p. 105]	Do.

H.

hamburgensis [Orthis], Walcott [1884b, p. 73]	Eoorthis desmopleura ?.
harlanensis [Billingsella], Walcott [1905a, p. 236]	Wimanella harlanensis.
hastingsensis [Orthis (Plectorthis)], Walcott [1905a, p. 263]	Eoorthis hastingsensis.
hawkei [Lingula], Roualt	Not taken up in this monograph; it does not equal Mickwitzia sp. undt.
hawkei? [Lingula], Bornemann [1891, p. 439]	Mickwitzia sp. undt.
haydeni [Micromitra], Walcott [1908d, pp. 55–56]	Micromitra haydeni.
hayesi [Obolus (Lingulella)], Walcott [1898b, pp. 405–406]	Lingulella hayesi.
heberti [Lingulella], Barrois [1882, pp. 185–186]	Lingulella heberti.
helena [Obolus (Lingulella)], Walcott [1898b, p. 406]	Lingulella helena.
helena [Protorthis], Walcott [1905a, p. 282]	Protorthis helena.
Helmersenia Hall and Clarke [1892a, p. 254]	Helmersenia.
Hall and Clarke [1892b, p. 570]	Do.
Hall and Clarke [1892c, p. 119]	Do.
Oehlert [1887, p. 1264]	Do.
Pander [1861, columns 48–49]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 143]	Do.
Zittel [1880, p. 666]	Do.
Helmersenia jeremejewi Dall [1877, p. 31]	Helmersenia ladogensis.
Oehlert [1887, p. 1264]	Do.
Helmersenia sp.? Hall and Clarke [1892a, p. 254]	Do.
Hall and Clarke [1892c, p. 119]	Do.
Pander [1861, columns 48–49]	Do.
hera [Acrothele subsidua], Walcott [1908d, p. 87]	Acrothele subsidua hera.
hicksi [Billingsella], Walcott [1905a, p. 237]	Billingsella hicksi.
hicksi [Orthis], Kayser [1883, p. 35]	Do.
Linnarsson [1876, pp. 13–14]	Billingsella exporrecta rugosicostata.
hicksii [Orthis], Davidson [1868, p. 314]	Billingsella hicksi.
Davidson [1869, p. 230]	Do.
highlandensis [Billingsella], Walcott [1905a, pp. 237–238]	Billingsella highlandensis.
highlandensis [Orthis?], Walcott [1886b, pp. 119–120]	Do.
Walcott [1891a, p. 612]	Do.
Huenella Walcott [1908d, p. 109]	Huenella.
Walcott [1908e, Pl. XI and pp. 142 and 148]	Do.
Huenella etheridgei Walcott [1908d, pp. 109–110]	Huenella etheridgei.
Huenella lesleyi Walcott [1908d, p. 110]	Huenella lesleyi.
Huenella vermontana Walcott [new]	Huenella vermontana.

Present reference.

humeratus [Obolus (Schmidtia) acuminatus], Mickwitz [1896, pp. 184–186]..Obolus (Schmidtia) acuminatus.
humillima [Lingula], Barrande [1868a, p. 101]....Lingulella? humillima.
Barrande [1868b, p. 691]....Do.
hunnebergensis [Protorthis?], Moberg and Segerberg [1906, pp. 70–71]....Protorthis? hunnebergensis.

I.

ida [Billingsia?], Ford [1886a, p. 467]....Elkania ida.
ida [Elkania], Ford [1886b, p. 325]....Do.
ida [Obolella], Billings [1862d, p. 71]....Do.
ida? [Obolella], Dawson [1888a, p. 55]....Acrotreta sagittalis.
Dawson [1888b, p. 55]....Do.
ida [Obolella?], Walcott [1886b, p. 111]....Elkania ida.
idahoensis [Acrotreta], Walcott [1902, p. 587]....Acrotreta idahoensis.
idahoensis [Acrotreta cf.], Walcott [new]....Acrotreta cf. idahoensis.
idahoensis alta [Acrotreta], Walcott [1902, p. 588]....Acrotreta idahoensis alta.
idahoensis sulcata [Acrotreta], Walcott [1902, p. 588]....Acrotreta idahoensis sulcata.
iddingsi [Orthis (Plectorthis)], Walcott [1905a, p. 264]....Eoorthis iddingsi.
inchoans [Acrothele], Matthew [1902b, p. 404]....Acrotreta inchoans.
Matthew [1903, p. 103]....Do.
inchoans [Acrotreta], Pompeckj [1896a, p. 3]....Do.
inchoans [Lingula], Barrande [1868a, p. 102]....Do.
Barrande [1868b, p. 692]....Do.
indianola [Orthis (Plectorthis)], Walcott [1905a, pp. 264–265]....Eoorthis indianola.
indianola [Plectorthis], Grabau and Shimer [1907, pp. 251–252]....Do.
inflata [Acrothyra?], Matthew [1901b, p. 304]....Acrotreta inflata.
inflata [Acrotreta], Walcott [1902, pp. 588–589]....Do.
inflata [Lingulella?], Matthew [1886, p. 33]....Do.
Matthew [1895a, p. 127]....Do.
Matthew [1898a, p. 128]....Do.
inflata [Lingulella (Acrothyra?)], Matthew [1902b, p. 390]....Do.
inflata ovalis [Lingulella?], Matthew [1895a, p. 127]....Do.
inflatus [Obolus?], Westergård [1909, p. 76]....Obolus? inflatus.
ingricus [Obolus], Eichwald [1829, p. 274]....Obolus apollinis ingricus.
Eichwald [1843b, pp. 140–141]....Do.
Eichwald [1860, pp. 926–927]....Do.
von Leuchtenberg [1843, p. 16]....Do.
ingricus [Obolus apollinis], Mickwitz [1896, pp. 137–140]....Do.
ino [Obolus (Lingulella)], Walcott [1898b, pp. 406–407]....Lingulella ino.
inornatus [Obolus triangularis], Mickwitz [1896, pp. 148–149]....Obolus triangularis.
insignis [Trematobolus], Hall and Clarke [1892a, p. 252]....Trematobolus insignis.
Hall and Clarke [1892b, p. 568]....Do.
Matthew [1893a, pp. 276–279]....Do.
Matthew [1894, pp. 88–90]....Do.
Matthew [1895a, pp. 122–125]....Do.
Matthew [1895c, p. 95]....Do.
Matthew [1898b, p. 35]....Do.
insons [Lingula], Barrande [1879b, Pl. CV, figs. x: 1–6]....Lingulella? insons.
insulæ [Leptobolus atavus], Matthew [1903, pp. 110–112]....Lingulella atava insulæ.
intermedia [Acrothele], Grönwall [1902, p. 39]....Acrothele intermedia.
Linnarsson [1879, pp. 25–27]....Do.
inyoensis [Wimanella], Walcott [1908d, p. 99]....Wimanella inyoensis.
iole [Lingula], Billings [1865a, p. 215]....Lingulella iole.
Iphidea Baly [1865]....Iphidea, not Micromitra. (See p. 332.)
Billings [1872b, pp. 477–478]....Micromitra.
Billings [1874, p. 76]....Do.
Dall [1877, p. 39]....Do.
Grabau and Shimer [1907, p. 201]....Micromitra (Paterina) (in part) and M. (Iphidella) (in part), not true Micromitra.
Hall and Clarke [1892a, p. 249]....Micromitra or Micromitra (Paterina).
Hall and Clarke [1892b, p. 565]....Do.
Hall and Clarke [1892c, pp. 97–98]....Micromitra.
Linnarsson [1876, p. 26]....Do.
Oehlert [1887, p. 1270]....Do.

	Present reference.
Iphidea Schuchert [1897, p. 233]	Micromitra and Micromitra (Paterina).
Walcott [1886b, pp. 100–101]	Micromitra.
Walcott [1897b, pp. 707–711]	Micromitra (in part), M. (Paterina) (in part), and M. (Iphidella) (in part).
Walcott [1899, pp. 447–448]	Micromitra.
Iphidea alabamaensis Walcott [1897b, pp. 713–714]	Micromitra alabamaensis.
Iphidea bella Billings [1872b, pp. 477–478]	Micromitra (Paterina) bella.
Billings [1874, p. 76]	Do.
Billings [1882, p. 13]	Do.
Clark and Mathews [1906, p. 252]	Do.
Grabau and Shimer [1907, p. 201]	Do.
Hall and Clarke [1892a, p. 249]	Micromitra (Paterina) labradorica swantonensis.
Hall and Clarke [1892c, p. 98, fig. 54]	Micromitra (Paterina) bella. The text includes both M. (P.) bella and M. (P.) labradorica swantonensis.
Hall and Clarke [1892c, p. 98, Pl. IV, figs. 8 and 9]	Micromitra (Paterina) labradorica swantonensis. The text includes both M. (P.) labradorica swantonensis and M. (P.) bella.
Oehlert [1887, p. 1270]	Micromitra (Paterina) bella.
Walcott [1886b, p. 100]	Do.
Walcott [1891a, p. 608]	Do.
Iphidea bella? Grabau [1900, pp. 617–618]	Do.
Iphidea crenistria Walcott [1897b, p. 713]	Micromitra (Paterina) crenistria.
Iphidea labradorica Billings [1872b, p. 478]	Micromitra (Paterina) labradorica.
Billings [1874, p. 76]	Do.
Schuchert [1897, p. 234]	Micromitra (Paterina) labradorica (in part) and M. (P.) labradorica swantonensis (in part).
Iphidea labradorica swantonensis Schuchert [1897, p. 234]	Micromitra (Paterina) labradorica swantonensis.
Iphidea logani Walcott [1897b, pp. 711–712]	Micromitra (Paterina) logani.
Iphidea ornatella Grönwall [1902, p. 40]	Micromitra (Iphidella) ornatella.
Hall and Clarke [1892c, pp. 97–98]	Do.
Linnarsson [1876, pp. 25–26]	Do.
Iphidea cnf.? ornatella Hall and Clarke [1892c, Pl. IV, figs. 6 and 7]	Micromitra (Paterina) superba.
Iphidea pannula Matthew [1902c, p. 110]	Micromitra (Iphidella) pannula.
Iphidea pannulus Grabau and Shimer [1907, p. 201]	Do.
Schuchert [1897, p. 234]	Do.
Iphidea pealei Walcott [1897b, pp. 712–713]	Micromitra pealei.
Iphidea prospectensis Schuchert [1897, p. 234]	Micromitra (Paterina) prospectensis.
Iphidea (??) sculptilis Meek [1873, p. 479]	Micromitra sculptilis.
Iphidea sculptilis Schuchert [1897, p. 235]	Do.
Walcott [1899, pp. 447–448]	Do.
Iphidea stissingensis Schuchert [1897, p. 234]	Micromitra (Paterina) stissingensis.
Iphidea superba Walcott [1897b, p. 711]	Micromitra (Paterina) superba.
Iphidea swantonensis Grabau and Shimer [1907, p. 201]	Micromitra (Paterina) labradorica swantonensis.
Iphidea sp. undet. Walcott [1899, p. 449]	Micromitra sp. undt.
Iphidella Walcott [1905a, p. 304]	Micromitra (in part), M. (Paterina) (in part), and M. (Iphidella) (in part).
(Iphidella) [Micromitra], Walcott [1908e, Pl. XI, and pp. 142 and 143]	Micromitra (Iphidella).
Iphidella labradorica Walcott [1905a, p. 307]	Micromitra (Paterina) labradorica.
Iphidella labradorica orientalis Walcott [1905a, pp. 305–306]	Micromitra (Paterina) labradorica orientalis.
Iphidella labradorica swantonensis Walcott [1905a, p. 307]	Micromitra (Paterina) labradorica swantonensis.
Iphidella labradorica utahensis Walcott [1905a, p. 306]	Micromitra (Paterina) labradorica utahensis.
(Iphidella) louise [Micromitra], Walcott [1908d, pp. 56–57]	Micromitra (Iphidella) louise.
Iphidella major Walcott [1905a, p. 304]	Micromitra (Paterina) major (in part) and M. (P.) williardi (in part).
Iphidella nisus Walcott [1905a, p. 305]	Micromitra nisus.

	Present reference.
(Iphidella) nyssa [Micromitra], Walcott [1908d, p. 57]	Micromitra (Iphidella) nyssa.
Iphidella pannula Walcott [1905a, p. 307]	Micromitra (Iphidella) pannula.
(Iphidella) pannula [Micromitra], Walcott [1908c, p. 244, Pl. I, figs. 1, 1a–c]	Do.
Iphidella pannula maladensis Walcott [1905a, p. 306]	Micromitra (Iphidella) pannula maladensis.
Iphidella pannula ophirensis Walcott [1905a, p. 306]	Micromitra (Iphidella) pannula ophirensis.
Iphidella prospectensis Walcott [1905a, p. 307]	Micromitra (Paterina) prospectensis.
Iphidella sculptilis Walcott [1905a, p. 308]	Micromitra sculptilis.
Iphidella stissingensis Walcott [1905a, p. 308]	Micromitra (Paterina) stissingensis.
Iphidella sp. undt. Walcott [1905a, p. 305]	Micromitra sp. undt.
iphis [Obolus (Westonia)], Walcott [1905a, p. 336]	Obolus (Westonia) iphis.
irene [Lingula], Billings [1862d, pp. 71–72]	Lingulella irene.
Billings [1863, p. 230]	Do.
irene [Lingulella], Schuchert [1897, p. 257]	Do.
iris [Lingula], Billings [1865a, p. 301]	Lingulella iris.
ismene [Obolus], Walcott [1905a, p. 325]	Obolus ismene.
isse [Obolus (Lingulella)], Walcott [1905a, p. 330]	Lingulella isse.

J.

(Jamesella) [Nisusia], Walcott [1905a, p. 252]	Nisusia (Jamesella).
Walcott [1908e, Pl. XI, and pp. 142 and 147]	Do.
(Jamesella) amii [Nisusia], Walcott [1905a, p. 252]	Nisusia (Jamesella) amii.
(Jamesella) argenta [Nisusia], Walcott [1905a, p. 252]	Nisusia (Jamesella) argenta.
(Jamesella) erecta [Nisusia], Walcott [1905a, p. 253]	Nisusia (Jamesella) erecta.
(Jamesella?) kanabensis [Nisusia?], Walcott [1908d, pp. 97–98]	Nisusia? (Jamesella?) kanabensis.
(Jamesella) kuthani [Nisusia], Walcott [1905a, pp. 253–254]	Nisusia (Jamesella) kuthani.
(Jamesella) lowi [Nisusia], Walcott [1908d, p. 98]	Nisusia (Jamesella) lowi.
(Jamesella) perpasta [Nisusia], Walcott [1905a, pp. 254–255]	Nisusia (Jamesella) perpasta.
(Jamesella) perpasta macra [Nisusia], Walcott [1905a, p. 255]	Nisusia (Jamesella) perpasta macra.
(Jamesella) perpasta subquadrata [Nisusia], Walcott [1905a, p. 255]	Nisusia (Jamesella) perpasta subquadrata.
(Jamesella) utahensis [Nisusia], Walcott [1905a, pp. 255–256]	Nisusia (Jamesella) utahensis.
(Jamesella) sp. undt. [Nisusia], Walcott [1905a, p. 256]	Nisusia (Jamesella) sp. undt.
jeremejewi [Helmersenia], Dall [1877, p. 31]	Helmersenia ladogensis.
Oehlert [1887, p. 1264]	Do.
johannensis [Orthis (Plectorthis)], Walcott [1905a, pp. 265–266]	Eoorthis johannensis.
johannensis [Orthisina (?)], Matthew [1892, pp. 49–50]	Do.

K.

kanabensis [Nisusia? (Jamesella?)], Walcott [1908d, pp. 97–98]	Nisusia? (Jamesella?) kanabensis.
kayseri [Orthis (Plectorthis)], Walcott [1905a, p. 266]	Eoorthis kayseri.
kempanum [Protosiphon], Matthew [1897a, pp. 70–71]	Trematobolus kempanum.
Matthew [1898a, p. 131]	Do.
Keyserlingia Dall [1877, p. 39]	Keyserlingia.
Hall and Clarke [1892c, pp. 117–119]	Do.
Karpinsky [1887, p. 476]	Helmersenia, not Keyserlingia.
Oehlert [1887, p. 1263]	Keyserlingia.
Pander [1861, p. 46]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 146]	Do.
Keyserlingia buchi Hall and Clarke [1892c, p. 118]	Keyserlingia buchi.
Pander [1861, columns 46–48]	Do.
Keyserlingia panderi Karpinsky [1887, p. 476]	Helmersenia ladogensis.
kichouensis [Orthis (Plectorthis)], Walcott [1906, p. 570]	Eoorthis kichouensis.
kiurensis [Lingula?], Waagen [1885a, pp. 768–769]	Lingulella kiurensis.
Waagen [1891, Pl. II, figs. 17a–b]	Do.
kuthani [Nisusia (Jamesella)], Walcott [1905a, pp. 253–254]	Nisusia (Jamesella) kuthani.
kuthani [Orthis], Pompeckj [1896b, pp. 514–515]	Do.
kutorgai [Acrotreta], Walcott [1902, pp. 589–590]	Acrotreta kutorgai (in part) and A. rudis (in part).
Kutorgina Beecher [1891, pp. 345–346]	Kutorgina.
Billings [1861b, p. 9]	Do.
Billings [1861c, p. 948]	Do.
Billings [1862e, p. 220]	Do.
Dall [1877, pp. 40–41]	Micromitra (Paterina) (in part) and Kutorgina (in part).

	Present reference.
Kutorgina Davidson [1868, p. 312]	Kutorgina.
Davidson [1871, p. 342]	Do.
Grabau and Shimer [1907, p. 209]	Do.
Hall and Clarke [1892a, pp. 247–248]	Do.
Hall and Clarke [1892b, pp. 563–564]	Do.
Hall and Clarke [1892c, pp. 90–94, and 183]	Micromitra (in part), Micromitra (Paterina) (in part), Micromitra (Iphidella) (in part), Kutorgina (in part), Protorthis (in part), and Billingsella (in part).
Oehlert [1887, p. 1262]	Kutorgina.
Walcott [1886b, pp. 101–102]	Kutorgina (in part), Micromitra (in part), Micromitra (Paterina) (in part), and Micromitra (Iphidella) (in part).
Walcott [1905a, pp. 306–308]	Kutorgina.
Walcott [1908e, Pl. XI, and pp. 142 and 145]	Do.
Zittel [1880, p. 664]	Do.
(Kutorgina) [Obolella], Dall [1870, pp. 154 and 163]	Do.
Kutorgina alata? Moberg [1892b, p. 113]	Belongs with an undetermined genus.
Kutorgina cingulata Beecher [1891, pp. 345–346]	Kutorgiua cingulata.
Bornemann [1891, p. 440]	Kutorgina sardiniaensis.
Davidson [1868, p. 312]	Micromitra (Paterina) phillipsi.
Davidson [1871, pp. 342–343]	Do.
Davidson [1883, p. 212]	Do.
Frech [1897, Pl. IA, figs. 6a–b]	Kutorgina cingulata.
Grabau and Shimer [1907, p. 209]	Do.
Hall and Clarke [1892a, Pl. IV, figs. 11–13]	Do.
Hall and Clarke [1892c, p. 92]	Do.
von Toll [1899, pp. 26–27]	Do.
Walcott [1886b, pp. 102–104]	Micromitra pusilla (in part), Micromitra (Paterina) phillipsi (in part), and Kutorgina cingulata (in part).
Walcott [1886b, pp. 102–104, Pl. IX, figs. 1, 1a–f]	Kutorgina cingulata.
Walcott [1886b, p. 103, Pl. IX, figs. 1g–h]	Rustella edsoni.
Walcott [1891a, p. 609, Pl. LXIX, figs. 1, 1a–f]	Kutorgina cingulata.
Walcott [1891a, p. 609, Pl. LXIX, figs. 1g–h]	Rustella edsoni.
Walcott [1905a, pp. 308–309]	Kutorgina cingulata.
(Kutorgina) cingulata [Obolella], Billings [1861b, pp. 8–9, figs. 8 and 10]	Do.
Billings [1861b, p. 8, fig. 9]	Rustella edsoni.
Billings [1861c, p. 948, figs. 347 and 349]	Kutorgina cingulata.
Billings [1861c, p. 948, fig. 348]	Rustella edsoni.
Billings [1862e, p. 220, figs. 347 and 349]	Kutorgina cingulata.
Billings [1862e, p. 220, fig. 348]	Rustella edsoni.
Kutorgina cingulata phillipsi Matley [1902, pp. 145–147]	Micromitra (Paterina) phillipsi.
Kutorgina cingulata pusilla Grönwall [1902, pp. 40–41]	Micromitra pusilla.
Linnarsson [1876, p. 25]	Do.
Matley [1902, pp. 146–147]	Do.
Kutorgina granulata Matthew [1899a, p. 189]	Kutorgina granulata.
Matthew [1899e, p. 98]	Do.
Kutorgina labradorica Walcott [1886b, p. 104]	Micromitra (Paterina) labradorica. The figures accompanying this reference [Pl. IX, figs. 2, 2a–b] represent M. (P.) labradorica swantonensis.
Walcott [1886b, Pl. IX, figs. 2, 2a–b]	Micromitra (Paterina) labradorica swantonensis. The text reference [p. 104] refers only to M. (P.) labradorica.
Walcott [1891a, p. 609]	Micromitra (Paterina) labradorica.
Kutorgina labradorica swantonensis Walcott [1890b, p. 36]	Micromitra (Paterina) labradorica swantonensis.
Walcott [1891a, p. 609]	Do.
Kutorgina latourensis Hall and Clarke [1892c, pp. 93, 95, and 233]	Protorthis latourensis.
Matthew [1886, pp. 42–43]	Do.
Kutorgina minutissima Hall and Whitfield [1877, pp. 207–208]	Micromitra sculptilis.

	Present reference.
Kutorgina pannula Pack [1906, p. 296]	Micromitra (Iphidella) pannula.
Walcott [1886b, p. 105]	Do.
Walcott [1887, p. 190]	Do.
Walcott [1891a, p. 609]	Do.
Kutorgina perugata Walcott [1905a, p. 310]	Kutorgina perugata.
Kutorgina prospectensis Walcott [1884b, p. 19]	Micromitra (Paterina) prospectensis.
Walcott [1886b, pp. 106–107]	Do.
Walcott [1891a, p. 610]	Do.
Kutorgina sardiniaensis Walcott [1901, p. 695]	Kutorgina sardiniaensis.
Walcott [1905a, p. 311]	Do.
Kutorgina sculptilis Walcott [1884b, p. 20]	Micromitra sculptilis.
Kutorgina stissingensis Dwight [1889, pp. 145–147]	Micromitra (Paterina) stissingensis.
Dwight [1891, p. 105]	Do.
Kutorgina undosa Moberg [1892b, p. 112]	Micromitra (Paterina) undosa.
Kutorgina whitfieldi Walcott [1884b, pp. 18–19]	Billingsella whitfieldi.
Kutorgina sp. Moberg [1892b, p. 114]	Micromitra? sp. (See p. 357.)
Kutorgina sp. undt. Walcott [1905a, p. 311]	Kutorgina sp. undt.

L.

labiosa [Discina], Salter [1866a, p. 285]	Acrotreta sagittalis.
labradorica [Iphidea], Billings [1872b, p. 478]	Micromitra (Paterina) labradorica.
Billings [1874, p. 76]	Do.
Schuchert [1897, p. 234]	Micromitra (Paterina) labradorica (in part) and M. (P.) labradorica swantonensis (in part).
labradorica [Iphidella], Walcott [1905a, p. 307]	Micromitra (Paterina) labradorica.
labradorica [Kutorgina], Walcott [1886b, p. 104]	Micromitra (Paterina) labradorica. The figures accompanying this reference [Pl. IX, figs. 2, 2a–b] represent M. (P.) labradorica swantonensis.
Walcott [1886b, Pl. IX, figs. 2, 2a–b]	Micromitra (Paterina) labradorica swantonensis. The text reference [p. 104] refers only to M. (P.) labradorica.
Walcott [1891a, p. 609]	Micromitra (Paterina) labradorica.
labradorica [Paterina], Beecher [1891, pp. 345–346]	Micromitra (Paterina) labradorica swantonensis.
Hall and Clarke [1892a, p. 247]	Do.
labradorica orientalis [Iphidella], Walcott [1905a, pp. 305–306]	Micromitra (Paterina) labradorica orientalis.
labradorica swantonensis [Iphidea], Schuchert [1897, p. 234]	Micromitra (Paterina) labradorica swantonensis.
labradorica swantonensis [Iphidella], Walcott [1905a, p. 307]	Do.
labradorica swantonensis [Kutorgina], Walcott [1890b, p. 36]	Do.
Walcott [1891a, p. 609]	Do.
labradorica utahensis [Iphidella], Walcott [1905a, p. 306]	Micromitra (Paterina) labradorica utahensis.
labradorica var. undt. [Micromitra (Paterina)], Walcott [new]	Micromitra (Paterina) labradorica var. undt.
labradoricus [Obolus], Billings [1861b, p. 6]	Micromitra (Paterina) labradorica.
Billings [1861c, p. 946]	Do.
Billings [1862e, p. 218]	Do.
Billings [1863, p. 284]	Do.
ladogensis [Siphonotreta], Jeremejew [1856, pp. 73 and 80]	Helmersenia ladogensis.
lævis [Acrothele subsidua], Walcott [new]	Acrothele subsidua lævis.
lævis [Lingulella], Matthew [1892, p. 39]	Lingulella lævis.
lævis [Protorthis], Walcott [1905a, p. 283]	Protorthis lævis.
lævis grandis [Lingulella], Matthew [1903, pp. 200–201]	Lingulella lævis grandis.
lævis lens [Lingulella], Matthew [1903, pp. 201–203]	Lingulella lens.
læviusculus [Orthis (Plectorthis) wichitaensis], Walcott [1905a, p. 272]	Eoorthis wichitaensis læviusculus.
læviusculus [Syntrophia texana], Walcott [1905a, pp. 294–295]	Huenella texana læviusculus.
Lakhmina Hall and Clarke [1892a, pp. 234–235]	Neobolus.
Hall and Clarke [1892b, pp. 550–551]	Do.
Hall and Clarke [1892c, pp. 28–30]	Do.
Oehlert [1887, p. 1265]	Do.
Waagen [1891, desc. of Pl. II, figs. 3 and 4]	Do.

	Present reference.
Lakhmina linguloides Frech [1897, Pl. IA, figs. 4a–b]	Neobolus warthi.
Hall and Clarke [1892a, p. 234]	Do.
Hall and Clarke [1892b, p. 550]	Do.
Hall and Clarke [1892c, p. 28]	Do.
Oehlert [1887, p. 1265]	Do.
Waagen [1891, desc. of Pl. II, figs. 3 and 4]	Do.
lamborni [Lingulella], Keyes [1894, pp. 38–39]	Obolus lamborni.
lamborni [Lingulella?], Meek [1871, pp. 185–187]	Do.
lamborni minimus [Obolus (Lingulella)], Walcott [1898b, p. 407]	Obolus lamborni minimus.
lamellosa [Lingula], Barrande [1879b, Pl. CVI, figs. I: 1–5; Pl. CXI, figs. IX: 1–3]	Obolus (Westonia?) lamellosus.
lamellosus [Obolus (Westonia?)], Walcott [1901, p. 691]	Do.
lata [Acrothele matthewi], Hall and Clarke [1892a, Pl. III, figs. 25 and 26]	Acrothele matthewi lata.
Hall and Clarke [1892c, Pl. III, figs. 26–28]	Do.
Matthew [1886, p. 41]	Do.
Matthew [1895a, Pl. V, figs. 8a–b]	Do.
Matthew [1903, p. 104]	Do.
lata [Acrotreta papillata], Matthew [1903, pp. 95–96]	Acrothyra sera.
lateralis [Syntrophia], Hall and Clarke [1892c, p. 270]	Syntrophia lateralis.
Hall and Clarke [1893b, p. 217]	Do.
Hall [1894a, p. 837]	Do.
lateralis [Triplesia], Whitfield [1886, p. 303]	Do.
latourensis [Kutorgina], Hall and Clarke [1892c, pp. 93, 95, and 233]	Protorthis latourensis.
Matthew [1886, pp. 42–43]	Do.
latourensis [Protorthis], Walcott [1905a, pp. 282–283]	Do.
latus [Obolus (Schmidtia) obtusus], Mickwitz [1896, pp. 174–175]	Obolus (Schmidtia) obtusus.
leda [Obolus tetonensis], Walcott [1908d, p. 63]	Obolus tetonensis leda.
lens [Lingula?], Matthew [1901a, pp. 274–275]	Lingulella lens.
lens [Lingulella], Matthew [1903, pp. 205–206]	Do.
lens [Lingulella lævis], Matthew [1903, pp. 201–203]	Do.
lens [Obolus], Matthew [1902c, p. 95]	Obolus (Palæobolus) bretonensis lens.
lens [Obolus (Lingulella)], Walcott [1902, pp. 606–607]	Lingulella lens.
lens [Obolus (Palæobolus)], Matthew [1903, pp. 144–146]	Obolus (Palæobolus) bretonensis lens.
lens longus [Obolus (Palæobolus)], Matthew [1903, pp. 146–147]	Do.
lens-primus [Obolus], Matthew [1902c, pp. 94–95]	Do.
lenticularis [Anomites], Wahlenberg [1821, pp. 66–67]	Orusia lenticularis.
lenticularis [Atrypa?], Dalman [1828, pp. 132–133]	Do.
Hisinger [1837, p. 76]	Do.
lenticularis [Atrypa], Kjerulf [1857, p. 92]	Do.
Kjerulf [1865, pp. 1 and 3]	Do.
Kjerulf [1879, Pl. XIII]	Do.
lenticularis [Orthis], Brögger [1882, p. 48]	Do.
Davidson [1868, p. 314]	Do.
Davidson [1869, pp. 230–232]	Do.
Matthew [1892, pp. 46–48]	Do.
Matthew [1903, pp. 213–216]	Do.
Roemer [1876, Pl. II, figs. 4a–c]	Do.
Roemer [1885, pp. 33–34]	Do.
Salter [1866b, p. 339]	Do.
Salter and Etheridge [1881, pp. 544–545]	Do.
lenticularis? [Orthis], Kayser [1876, p. 9]	Do.
lenticularis [Orthis (Orusia)], Walcott [1905a, pp. 273–276]	Do.
lenticularis [Spirifera?], von Buch [1834, p. 48]	Do.
lenticularis atrypoides [Orthis], Matthew [1892, p. 48]	Orusia lenticularis atrypoides.
Matthew [1903, p. 217]	Do.
lenticularis atrypoides [Orthis (Orusia)], Walcott [1905a, p. 276]	Do.
lenticularis lyncioides [Orthis], Matthew [1892, p. 49]	Orusia lenticularis lyncioides.
Matthew [1903, p. 216]	Do.
lenticularis lyncioides [Orthis (Orusia)], Walcott [1905a, p. 277]	Do.
lenticularis strophomenoides [Orthis], Matthew [1892, p. 49]	Orusia lenticularis.
Matthew [1903, p. 217]	Do.
leos [Obolus (Lingulella)], Walcott [1898b, pp. 407–408]	Lingulella leos.
lepis [Lingula?], Davidson [1866, p. 54]	Lingulella lepis.

	Present reference.
lepis [Lingula], Salter [1859, p. 543]	Lingulella lepis.
lepis [Lingula (Lingulella?)], Brögger [1882, p. 44]	Do.
lepis [Lingula (Lingulella)], Davidson [1866, desc. of Pl. III]	Do.
lepis [Lingulella], Davidson [1868, pp. 307–308]	Do.
Davidson [1871, Pl. XLIX, figs. 31 and 31a]	Do.
Holm [1898, p. 148]	Do.
Moberg and Segerberg [1906, pp. 62–63]	Do.
Salter [1866b, p. 334]	Do.
Salter and Etheridge [1881, p. 538]	Do.
lepis [Lingulella cf.], Matthew [1903, p. 204]	Do.
lepis? [Lingulella], Westergård [1909, p. 57]	Do.
Wiman [1902, pp. 66 and 71]	Do.
Leptæna barabuensis Whitfield [1878, p. 60]	Syntrophia barabuensis.
Whitfield [1882, pp. 171–172 and 195]	Do.
Leptæna melita Hall and Whitfield [1877, p. 208]	Variety of Eoorthis desmopleura.
(Leptembolon) [Obolus], Mickwitz [1896, p. 199]	Lingulella (Leptembolon).
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
(Leptembolon) lingulæformis [Obolus], Mickwitz [1896, pp. 200–204]	Lingulella (Leptembolon) lingulæformis.
(Leptembolon) lingulæformis solidus [Obolus], Mickwitz [1896, pp. 204–205]	Do.
Leptobolus Matthew [1903, pp. 105–106]	Lingulella.
Leptobolus atavus Matthew [1899b, pp. 200–201]	Lingulella atava.
Matthew [1903, pp. 106–109]	Do.
Leptobolus atavus insulæ Matthew [1903, pp. 110–112]	Lingulella atava insulæ.
Leptobolus atavus tritavus Matthew [1903, p. 109]	Lingulella torrentis.
Leptobolus? collicia Matthew [1899b, p. 200]	Lingulella collicia.
Leptobolus collicia Matthew [1903, pp. 112–113]	Do.
Leptobolus collicia collis Matthew [1903, pp. 114–115]	Do.
Leptobolus flumenis Matthew [1903, pp. 189–190]	Lingulella flumenis.
Leptobolus gemmulus Matthew [1903, pp. 190–192]	Lingulella ferruginea.
Leptobolus grandis Matthew [1894, pp. 91–92]	Lingulella grandis.
Leptobolus cf. grandis Matthew [1902c, p. 111]	Does not equal Lingulella grandis. It is not referred in this monograph.
Leptobolus linguloides Matthew [1902b, p. 407]	Lingulella ferruginea.
Matthew [1903, p. 193]	Do.
Leptobolus cf. linguloides Matthew [1902b, p. 407]	Do.
Matthew [1903, pp. 192–193]	Do.
Leptobolus torrentis Matthew [1903, pp. 74–75]	Lingulella torrentis.
lesleyi [Huenella], Walcott [1908d, p. 110]	Huenella lesleyi.
levisensis [Acrothele], Walcott [1908d, p. 85]	Acrothele levisensis.
liani [Acrotreta], Walcott [1905a, p. 300]	Acrotreta lisani.
limöensis [Acrotreta], Wiman [1902, p. 54]	Acrotreta uplandica limöensis.
limonensis [Acrotreta uplandica], Walcott [1905a, p. 303]	Do.
lindstromi [Billingsella], Walcott [1905a, pp. 238–239]	Billingsella lindströmi.
lindströmi [Obolella], Walcott [1901, pp. 674–675]	Obolella? lindströmi.
lindströmi [Orthis], Linnarsson [1876, pp. 10–12]	Billingsella lindströmi.
lineolatus [Obolus (Lingulella)], Walcott [1898b, pp. 408–409]	Lingulella lineolata.
Lingula acuminata Billings [1863, p. 102]	Lingulella (Lingulepis) acuminata.
Chapman [1863, p. 187]	Do.
Chapman [1864, p. 159]	Do.
Conrad [1839, p. 64]	Do.
Emmons [1855, p. 203]	Do.
Hall [1847, p. 9]	Do.
Lingula acutangula Roemer [1849, p. 420]	Lingulella acutangula.
Roemer [1852, p. 90]	Do.
Lingula agnostorum Wallerius [1895, pp. 64–65]	Lingulella agnostorum.
Lingula ampla Hall [1863, p. 125]	Lingulella ampla.
Hall [1867, pp. 101–102]	Do.
Owen [1852, p. 583]	Do.
Lingula ancilla Barrande [1879b, Pl. CXI, fig. VI]	Obolus? ancillus.
Lingula antiqua Billings [1856, p. 34]	Lingulella (Lingulepis) acuminata.
Emmons [1842, p. 268]	Do.
Emmons [1863, p. 92]	Do.
Hall [1847, pp. 3–4]	Do.

	Present reference.
Lingula antiqua Hall [1851, pp. 204–205]	Lingulella (Lingulepis) acuminata.
Hall [1862, fig. 2, p. 21]	Do.
Hayden [1862, p. 73]	Do.
James [1895, p. 884]	Do.
Owen [1851, p. 170]	Do.
Rogers [1861, p. 390]	Obolus (Westonia) rogersi.
Lingula antiquata Emmons [1855, pp. 202–203]	Lingulella (Lingulepis) acuminata.
Lingula attenuata Bornemann [1891, pp. 437–438]	Lingulella bornemanni.
Lingula aurora Hall [1861, p. 24]	Obolus (Westonia) aurora.
Hall [1862, p. 21]	Do.
Hall [1863, pp. 126–127]	Do.
Hall [1867, pp. 103–104]	Do.
Sardeson [1896, p. 95]	Do.
Lingula aurora var. Hall [1863, pp. 127–128]	Obolus (Westonia) stoneanus.
Hall [1867, pp. 104–106]	Do.
Lingula bavarica Barrande [1868a, p. 100]	Obolus? bavaricus.
Barrande [1868b, pp. 690–691]	Do.
Lingula belli Billings [1859, pp. 431–432]	Obolus belli.
Billings [1863, figs. 47a–b, p. 124]	Do.
Lingula billingsana Matthew [1903, p. 205]	Lingulella bellula.
Lingula billingsiana Whiteaves [1878, p. 226]	Lingulella billingsiana.
Lingula cf. billingsiana Matthew [1894, p. 93]	Lingulella grandis.
Lingula bottnica Wiman [1902, p. 51]	Obolus (Westonia) bottnicus.
Lingula? bryograptorum Moberg and Segerberg [1906, p. 63]	Lingulella lepis.
Westergård [1909, p. 57]	Do.
Lingula cedens Barrande [1868a, p. 102]	Lingulella cedens.
Barrande [1868b, pp. 691–692]	Do.
Lingula? corrugata Moberg and Segerberg [1906, p. 63]	Lingulella lepis.
Westergård [1909, p. 57]	Do.
Lingula cyane Billings [1865a, p. 216]	Obolus cyane.
Lingula dakotensis Meek and Hayden [1865, p. 3]	Lingulella (Lingulepis) acuminata.
Whitfield [1880, pp. 337–338]	Do.
Lingula davidsoni Barrande [1879b, Pl. CIV, figs. VIII: 1–4]	Lingulella davidsoni.
Lingula davisi McCoy [1851b, pp. 405–406]	Lingulella davisi.
McCoy [1854, p. 252]	Do.
Lingula cf. davisi Schmidt [1881, p. 17, fig. 5]	Obolus (Mickwitzella) siluricus.
Lingula? dawsoni Matthew MS. [1884]	Lingulella ferruginea.
Walcott [1884a, p. 15]	Do.
Lingula dolata Sardeson [1896, p. 95]	Obolus dolatus.
Lingula aff. exungui Gürich [1896, p. 214]	Lingulella siemiradzkii.
Lingula cf. exunguis Gürich [1892, p. 69]	Do.
Siemiradzki [1886, p. 672]	Do.
Lingula (?) favosa Linnarsson [1869a, pp. 356–357]	Obolella (Glyptias) favosa.
Linnarsson [1869b, p. 406]	Do.
Lingula feistmanteli Barrande [1879b, Pls. CVI and CX]	Obolus feistmanteli.
Lingula hawkei Roualt	Not taken up in this monograph; it does not equal Mickwitzia sp. undt.
Lingula hawkei? Bornemann [1891, p. 439]	Mickwitzia sp. undt.
Lingula humillima Barrande [1868a, p. 101]	Lingulella? humillima.
Barrande [1868b, p. 691]	Do.
Lingula inchoans Barrande [1868a, p. 102]	Acrotreta inchoans.
Barrande [1868b, p. 692]	Do.
Lingula insons Barrande [1879b, Pl. CV, figs. X: 1–6]	Lingulella? insons.
Lingula iole Billings [1865a, p. 215]	Lingulella iole.
Lingula irene Billings [1862d, pp. 71–72]	Lingulella irene.
Billings [1863, p. 230]	Do.
Lingula iris Billings [1865a, p. 301]	Lingulella iris.
Lingula? kiurensis Waagen [1885a, pp. 768–769]	Lingulella kiurensis.
Waagen [1891, Pl. II, figs. 17a–b]	Do.
Lingula lamellosa Barrande [1879b, Pl. CVI, figs. I: 1–5; Pl. CXI, figs. IX: 1–3]	Obolus (Westonia?) lamellosus.
Lingula? lens Matthew [1901a, pp. 274–275]	Lingulella lens.
Lingula? lepis Davidson [1866, p. 54]	Lingulella lepis.
Lingula lepis Salter [1859, p. 543]	Do.

	Present reference.
Lingula? manticula Walcott [1884b, pp. 13–14]	Lingulella punctata.
White [1874, pp. 9–10]	Lingulella arguta (in part) and L. manticula (in part).
White [1877, pp. 52–53, Pl. III, fig. 2a]	Lingulella arguta. The text also includes L. manticula.
White [1877, p. 52, Pl. III, fig. 2b]	Lingulella manticula. The text includes L. arguta.
Lingula matthewi Hartt [1868, p. 644]	Acrothele matthewi.
Hartt [1878, p. 644]	Do.
Hartt [1891, p. 644]	Do.
Lingula? miranda Barrande [1879b, Pl. CXI]	Obolus? mirandus.
Lingula? monilifera Linnarsson [1869a, p. 344]	Mickwitzia monilifera.
Lingula monilifera Linnarsson [1869b, p. 398]	Do.
Lingula mosia Hall [1863, p. 126]	Lingulella mosia.
Hall [1867, pp. 102–103]	Do.
Sardeson [1896, p. 95]	Do.
Lingula? ordovicensis Moberg and Segerberg [1906, p. 63]	Lingulella lepis.
Lingula ovata Emmons [1842, p. 105]	Lingulella prima.
McCoy [1846, p. 24]	Lingula ovata, not Lingulella davisi.
McCoy [1854, p. 254]	Lingulella davisi (in part) and Lingula ovata (in part).
Lingula petalon Bornemann [1891, p. 438]	Obolus? meneghinii.
Davidson [1868, p. 308]	Does not equal Obolus? meneghinii.
Davidson [1871, p. 337]	Does not equal Obolus? meneghinii.
Lingula pinnaformis Owen [1852, p. 583]	Lingulella (Lingulepis) acuminata.
Lingula pinnæformis Hall [1862, p. 435, and fig. 3, p. 21]	Do.
Lingula polita Hall [1861, p. 24]	Dicellomus politus.
Lingula? polita Hall [1862, pp. 21 and 435]	Do.
Lingula polita Whitfield [1862, p. 136]	Do.
Lingula prima Billings [1856, p. 34]	Lingulella (Lingulepis) acuminata.
Emmons [1855, p. 202]	Lingulella prima.
Hall [1847, p. 3]	Do.
Hall [1851, p. 204]	Lingulella (Lingulepis) acuminata.
Hayden [1862, p. 73]	Probably equals Lingulella (Lingulepis) acuminata.
Owen [1851, p. 170]	Lingulella (Lingulepis) acuminata.
Rogers [1861, p. 390]	Obolus (Westonia) rogersi.
Lingula? producta Moberg and Segerberg [1906, p. 63]	Lingulella lepis.
Lingula pygmæa Davidson [1866, p. 53]	Lingulella (Lingulepis?) pygmæa.
Matley [1902, p. 141]	Do.
Phillips [1871, p. 68]	Do.
Salter [1865, p. 102]	Do.
Lingula roualti Bornemann [1891, p. 439]	Kutorgina sardiniaensis.
Lingula? signata Barrande [1868a, p. 103]	Lingulella signata.
Barrande [1868b, p. 692]	Do.
Lingula simplex Barrande [1879b, Pl. CIV, figs. VI: 1–4]	Lingulella? simplex.
?Lingula squamosa Davidson [1866, p. 41]	Lingulella (Lingulepis?) squamosa.
Lingula squamosa Holl [1865, p. 102]	Do.
Lingula? warthi Waagen [1885a, pp. 769–770]	Lingulella kiurensis.
Waagen [1891, Pl. II, figs. 18a–b]	Do.
Lingula winona Hall [1863, p. 126]	Lingulella winona.
Hall [1867, p. 102]	Do.
Sardeson [1896, p. 96]	Do.
Lingula wirthi Barrande [1868a, p. 101]	Lingulella wirthi.
Barrande [1868b, p. 691]	Do.
Lingula sp. Davis [1846, p. 70]	Lingulella davisi.
Sedgwick [1847, pp. 140, 143, and 147]	Do.
Lingula? sp. No. 1 Wiman [1902, p. 51]	Obolus (Westonia) wimani.
No. 2 Wiman [1902, p. 52]	Obolus (Westonia) ålandensis.
Lingula or Lingulella sp. Linnarsson [1876, pp. 15–16]	Doubtfully equals Lingulella ferruginea.
Lingula (Glossina) acuminata Hall and Clarke [1892c, Pl. I, figs. 1 and 2]	Lingulella (Lingulepis) acuminata sequens.

	Present reference.
Lingula (Lingulella) Oehlert, [1887, p. 1261]	Lingulella.
Lingula (Lingulella?) lepis Brögger [1882, p. 44]	Lingulella lepis.
Lingula (Lingulella) lepis Davidson [1866, desc. of Pl. III]	Do.
Lingula (Lingulepis) Oehlert [1887, p. 1261]	Lingulella (Lingulepis).
lingulæ-comes [Tellinomya], McCoy [1851a, p. 56]	Lingulella davisi.
Salter	Does not equal Lingulella davisi.
lingulæformis [Obolus (Leptembolon)], Mickwitz [1896, pp. 200–204]	Lingulella (Leptembolon) lingulæformis.
lingulæformis solidus [Obolus (Leptembolon)], Mickwitz [1896, pp. 204–205]	Do.
Lingulella Bornemann [1891, pp. 435–437]	Lingulella.
Dall [1870, pp. 153 and 159]	Do.
Dall [1877, p. 44]	Do.
Davidson [1866, p. 55]	Do.
Davidson [1868, p. 304]	Do.
Delgado [1904, p. 367]	Do.
Grabau and Shimer [1907, p. 192]	Obolus (Westonia).
Hall and Clarke [1892a, pp. 232–233]	Lingulella (in part) and Botsfordia (in part)
Hall and Clarke [1892b, pp. 548–549]	Lingulella.
Hall and Clarke [1892c, pp. 55–59]	Lingulella (in part), Botsfordia (in part), Obolus (Westonia) (in part), etc.
Matthew [1899b, p. 201]	Lingulella.
Matthew [1902c, p. 103]	Do.
Matthew [1903, p. 116]	Do.
Meek [1871, pp. 186–187]	Do.
Salter [1866b, p. 333]	Do.
Salter and Etheridge [1881, p. 537]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
Zittel [1880, pp. 663–664]	Do.
(Lingulella) [Lingula], Oehlert [1887, p. 1261]	Do.
(Lingulella) [Obolus], Walcott [1898b, pp. 390–392]	Do.
Walcott [1901, p. 683]	Do.
(Lingulella) acutangulus [Obolus], Walcott [1898b, pp. 393 and 394, Pls. XXVII and XXVIII]	Lingulella acutangula.
Lingulella? affinis Billings [1872b, p. 468]	Obolus (Lingulobolus) affinis.
Billings [1874, p. 67]	Do.
Lingulella affinis Billings [1882, pp. 15–16]	Do.
Lingulella ampla Schuchert [1897, p. 257]	Lingulella ampla.
(Lingulella) amplus [Obolus], Walcott [1898b, pp. 392 and 394, Pl. XXVIII]	Do.
(Lingulella) argutus [Obolus] Walcott [1898b, p. 396]	Lingulella arguta.
(Lingulella) atavus [Obolus], Walcott [1902, pp. 609–610]	Lingulella atava.
(Lingulella) auga [Obolus], Walcott [1898b, pp. 396–397]	Lingulella auga.
Lingulella aurora Grabau and Shimer [1907, p. 193]	Obolus (Westonia) aurora.
Hall [1873, pp. 244–245]	Do.
Hall and Clarke [1892c, Pl. II, figs. 12 and 13]	Do.
Lingulella aurora var. Hall [1873, pp. 244–245]	Obolus (Westonia) stoneanus.
(Lingulella) bellulus [Obolus], Matthew [1903, p. 205]	Lingulella bellula.
Walcott [1898b, p. 398]	Do.
(Lingulella) bellus [Obolus], Matthew [1903, p. 204]	Lingulella bella.
Walcott [1898b, pp. 397–398]	Do.
Walcott [1901, pp. 685–687]	Lingulella bella (in part), L. concinna (in part), and L. lens (in part).
(Lingulella) bicensis [Obolus], Walcott [1901, p. 688]	Botsfordia cælata.
Lingulella? billingsana Schuchert [1897, p. 256]	Lingulella grandis (in part) and L. billingsiana (in part).
(Lingulella) bornemanni [Obolus], Walcott [1901, pp. 687–688]	Lingulella bornemanni.
Lingulella buttsi Walcott [1908d, pp. 70–71]	Lingulella buttsi.
Lingulella cælata Ford [1878, pp. 127–128]	Botsfordia cælata.
Hall and Clarke [1892a, Pl. III, figs. 1–4]	Do.
Hall and Clarke [1892c, pp. 57 and 58]	Do.
Walcott [1886b, p. 95]	Do.
Walcott [1887, p. 199, Pl. I, fig. 16]	Do.
Walcott [1891a, p. 607]	Do.
(Lingulella) canius [Obolus], Walcott [1902, pp. 610–611]	Lingulella cania.

	Present reference.
(Lingulella) celatus [Obolus], Walcott [1898b, Pl. XXVI, figs. 1 and 2]	Obolus (Schmidtia) celatus.
(Lingulella) chinensis [Obolus], Walcott [1905a, pp. 328–329]	Obolus chinensis.
(Lingulella) chuarensis [Obolus], Walcott [1898b, p. 399]	Obolus (Westonia) chuarensis.
Lingulella clarkei Walcott [new]	Lingulella clarkei.
Lingulella? cœlata Matthew [1895a, p. 126]	Botsfordia cælata.
(Lingulella) collicia [Obolus], Walcott [1902, p. 610]	Lingulella collicia.
Lingulella concinna Matthew [1901a, pp. 273–274]	Lingulella concinna.
Matthew [1903, pp. 203–204]	Do.
(Lingulella) concinnus [Obolus], Walcott [1902, pp. 608–609]	Do.
Lingulella? cuneata Matthew [1894, pp. 92–93]	Lingulella grandis.
(Lingulella) cuneolus [Obolus], Walcott [1899, p. 443]	Lingulella cuneola.
(Lingulella) damesi [Obolus], Walcott [1905a, p. 329]	Obolus damesi. (See Lingulella damesi, p. 489.)
Lingulella davisi Davidson [1868, pp. 304 and 306]	Lingulella davisi.
Hall and Clarke [1892a, p. 232]	Do.
Hall and Clarke [1892b, p. 548]	Do.
Hall and Clarke [1892c, pp. 56 and 57]	Do.
Meek [1871, pp. 186–187]	Do.
Salter [1866b, pp. 333–334]	Do.
Lingulella davisii Davidson [1866, pp. 56 and 57]	Do.
Hall [1873, Pl. XIII, fig. 4]	Do.
Roemer [1876, Pl. II, figs. 5a–c]	Do.
Salter [1867, pp. 44 and 52]	Do.
Salter and Etheridge [1881, pp. 537–538]	Do.
Lingulella cf. davisii Kayser [1897, p. 280]	Do.
Matthew [1902b, pp. 407–408]	Do.
Matthew [1903, p. 203]	Do.
(Lingulella) davisii [Obolus], Walcott [1898b, pp. 394 and 395]	Do.
Lingulella dawsoni Hall and Clarke [1892c, p. 58]	Lingulella ferruginea.
Matthew [1886, pp. 33–34, Pl. V, figs. 9, 9a–c]	Lingulella martinensis. The text includes L. ferruginea.
Matthew [1886, pp. 33–34, Pl. V, fig. 9d]	Lingulella ferruginea. The text includes L. martinensis.
Lingulella delgadoi Walcott [new]	Lingulella delgadoi.
(Lingulella) desideratus [Obolus], Walcott [1898b, pp. 399–400]	Lingulella desiderata.
Walcott [1899, pp. 445–446, Pl. LX, fig. 2]	Do.
Walcott [1899, pp. 445–446, Pl. LX, fig. 2a]	Obolus rotundatus.
(Lingulella) discoideus [Obolus], Walcott [1901, p. 673]	Obolus discoideus.
(Lingulella) dubius [Obolus], Walcott [1898b, p. 401]	Lingulella dubia.
Lingulella ella Hall and Clarke [1892c, p. 58, figs. 19 and 21]	Obolus (Westonia) ella. The text includes also specimens representing Lingulella dubia.
Hall and Clarke [1892c, p. 58, fig. 20]	Lingulella dubia.
Pack [1906, p. 295]	Obolus (Westonia) ella.
Walcott [1886b, pp. 97–98, Pl. VII, fig. 2; Pl. VIII, figs. 4, 4a, 4d–e]	Obolus (Westonia) ella. The text includes also specimens representing Lingulella dubia.
Walcott [1886b, pp. 97–98, Pl. VIII, figs. 4b–c]	Lingulella dubia. The text includes Obolus (Westonia) ella.
Walcott [1891a, p. 607, Pl. LXVII, figs. 2c–d]	Lingulella dubia. The text includes Obolus (Westonia) ella.
Walcott [1891a, p. 607, Pl. LXVII, figs. 2, 2a–b, and 2e]	Obolus (Westonia) ella. The text includes also specimens representing Lingulella dubia.
(Lingulella) ella [Obolus], Walcott [1898b, Pl. XXVIII, figs. 5–8]	Obolus (Westonia) ella.
(Lingulella) ellsi [Obolus], Walcott [1898b, p. 402]	Lingulella ellsi.
Lingulella (?) escasoni Matthew [1901a, pp. 270–273]	Obolus (Westonia) escasoni.
(Lingulella) euglyphus [Obolus], Walcott [1898b, pp. 402–403]	Obolus (Westonia) euglyphus.
Lingulella? cf. Lingula favosa Matthew [1888, pp. 28–29]	Botsfordia pulchra.
Lingulella ferruginea Davidson [1868, pp. 306–307]	Lingulella ferruginea.

	Present reference.
Lingulella ferruginea Davidson [1871, pp. 336–337]	Lingulella ferruginea.
Davidson [1883, Pl. XVII, fig. 35]	Do.
Delgado [1904, pp. 368–369]	Lingulella delgadoi.
Matthew [1903, p. 108]	Lingulella ferruginea.
Salter [Salter and Hicks, 1867, p. 340]	Do.
Salter and Etheridge [1881, p. 538]	Do.
Lingulella cf. ferruginea Kayser [1897, p. 280]	Do.
Lingulella ferruginea ovalis Davidson [1868, p. 307]	Do.
Hicks [Salter and Hicks, 1867, p. 341]	Do.
(Lingulella) fragilis [Obolus], Walcott [1898b, p. 404]	Obolus fragilis.
(Lingulella) franklinensis [Obolus], Walcott [1898b, pp. 404–405]	Lingulella franklinensis.
Lingulella fuchsi Redlich [1899, p. 7]	Lingulella fuchsi.
(Lingulella) fuchsi [Obolus], Walcott [1905a, p. 332]	Do.
(Lingulella) gemmulus [Obolus], Walcott [1901, p. 673]	Lingulella ferruginea.
Lingulella genei Pack [1906, p. 295]	Lingulella dubia.
Lingulella granvillensis Delgado [1904, pp. 367–368]	Lingulella delgadoi.
Hall and Clarke [1892c, p. 58]	Lingulella granvillensis.
Oehlert [1889, p. 1138]	Do.
Walcott [1887, pp. 188–189]	Do.
Walcott [1891a, pp. 607–608]	Do.
Lingulella cf. granvillensis Matthew [1895a, pp. 114–115]	Lingulella martinensis.
Lingulella gregwa Matthew [1899b, pp. 199–200]	Lingulella (Lingulepis) gregwa.
(Lingulella) hayesi [Obolus], Walcott [1898b, pp. 405–406]	Lingulella hayesi.
Lingulella heberti Barrois [1882, pp. 185–186]	Lingulella heberti.
(Lingulella) helena [Obolus], Walcott [1898b, p. 406]	Lingulella helena.
Lingulella? inflata Matthew [1886, p. 33]	Acrotreta inflata.
Matthew [1895a, p. 127]	Do.
Matthew [1898a, p. 128]	Do.
Lingulella? inflata ovalis Matthew [1895a, p. 127]	Do.
(Lingulella) ino [Obolus], Walcott [1898b, pp. 406–407]	Lingulella ino.
Lingulella irene Schuchert [1897, p. 257]	Lingulella irene.
(Lingulella) isse [Obolus], Walcott [1905a, p. 330]	Lingulella isse.
Lingulella lævis Matthew [1892, p. 39]	Lingulella lævis.
Lingulella lævis grandis Matthew [1903, pp. 200–201]	Lingulella lævis grandis.
Lingulella lævis lens Matthew [1903, pp. 201–203]	Lingulella lens.
Lingulella lamborni Keyes [1894, pp. 38–39]	Obolus lamborni.
Lingulella? lamborni Meek [1871, pp. 185–187]	Do.
(Lingulella) lamborni minimus [Obolus], Walcott [1898b, p. 407]	Obolus lamborni minimus.
Lingulella lens Matthew [1903, pp. 205–206]	Lingulella lens.
(Lingulella) lens [Obolus], Walcott [1902, pp. 606–607]	Do.
(Lingulella) leos [Obolus], Walcott [1898b, pp. 407–408]	Lingulella leos.
Lingulella lepis Davidson [1868, pp. 307–308]	Lingulella lepis.
Davidson [1871, Pl. XLIX, figs. 31 and 31a]	Do.
Holm [1898, p. 148]	Do.
Moberg and Segerberg [1906, pp. 62–63]	Do.
Salter [1866b, p. 334]	Do.
Salter and Etheridge [1881, p. 538]	Do.
Lingulella lepis? Westergård [1909, p. 57]	Do.
Wiman [1902, pp. 66 and 71]	Do.
Lingulella cf. lepis Matthew [1903, p. 204]	Do.
(Lingulella) lepis [Lingula], Davidson [1866, desc. of Pl. III]	Do.
(Lingulella?) lepis [Lingula], Brögger [1882, p. 44]	Do.
(Lingulella) lineolatus [Obolus], Walcott [1898b, pp. 408–409]	Lingulella lineolata.
Lingulella linguloides Matthew [1886, p. 34]	Lingulella ferruginea.
Lingulella cf. linguloides Delgado [1904, pp. 369–370]	Lingulella delgadoi.
(Lingulella) linnarssoni [Obolus], Walcott [1901, p. 688]	Lingulella linnarssoni.
Lingulella longovalis Matthew [1903, pp. 123–125]	Lingulella triparilis.
Lingulella mcconnelli Matthew [1902c, p. 108]	Obolus mcconnelli.
Walcott [1889c, p. 441]	Do.
Linguella? mæra Hall and Clarke [1892c, p. 61]	Obolus mæra.
Walcott [1897a, p. 404]	Do.
(Lingulella) mæra [Obolus], Walcott [1899, p. 443]	Do.

	Present reference.
Lingulella martinensis Matthew [1890, pp. 155–156]	Lingulella martinensis.
Matthew [1895a, pp. 113–114]	Do.
Lingulella? matinalis Walcott [1897a, p. 404]	Obolus matinalis.
(Lingulella) matinalis [Obolus], Walcott [1899, p. 443]	Do.
Lingulella minuta Schuchert [1897, p. 257]	Linnarssonella minuta.
(Lingulella) mosia osceola [Obolus], Walcott [1898b, p. 409]	Lingulella mosia osceola.
(Lingulella) nanno [Obolus], Walcott [1898b, p. 409]	Lingulella nanno.
Lingulella? nathorsti Linnarsson [1876, pp. 15–16]	Lingulella nathorsti.
Lingulella nicholsoni Callaway [1874, p. 196]	Lingulella nicholsoni.
Callaway [1877, pp. 668–669]	Do.
Davidson [1883, pp. 208–209]	Do.
Lingulella nicholsoni? Matley [1902, p. 141]	Do.
(Lingulella) orus [Obolus], Walcott [1905a, p. 330]	Lingulella ora.
(Lingulella) oweni [Obolus], Walcott [1898b, p. 410]	Lingulella oweni.
(Lingulella) pelias [Obolus], Walcott [1905a, pp. 330–331]	Obolus mcconnelli pelias.
(Lingulella) perattenuatus [Obolus], Walcott [1899, p. 443]	Lingulella perattenuata.
(Lingulella) phaon [Obolus], Walcott [1898b, pp. 410–411]	Lingulella phaon.
(Lingulella) pogonipensis [Obolus], Walcott [1898b, pp. 411–412]	Lingulella pogonipensis.
Lingulella? prima Hall and Clarke [1892c, p. 69]	Lingulella prima.
Lingulella primæva Davidson [1883, p. 208]	Lingulella? primæva.
Hicks [1871, p. 401]	Do.
Hicks [1881, p. 297]	Do.
Salter and Etheridge [1881, p. 538]	Do.
(Lingulella) prindlei [Obolus], Walcott [1898b, p. 412]	Obolus prindlei.
(Lingulella) punctatus [Obolus], Walcott [1898b, pp. 412–413]	Lingulella punctata.
(Lingulella) quadrilateralis [Obolus], Walcott [1905a, p. 331]	Lingulella quadrilateralis.
Lingulella radula Matthew [1891, pp. 147–148]	Lingulella radula.
Lingulella radula aspera Matthew [1903, pp. 204–205]	Do.
(Lingulella) randomensis [Obolus], Walcott [1901, pp. 688–689]	Lingulella randomensis.
Lingulella roberti Matthew [1895b, pp. 256–257]	Lingulella (Lingulepis) roberti.
Lingulella rogersi Grabau [1900, pp. 624–625]	Obolus (Westonia) rogersi.
(Lingulella) rogersi [Obolus], Walcott [1898b, pp. 413–415]	Do.
(Lingulella) rotundatus [Obolus], Walcott [1898b, p. 415]	Obolus rotundatus.
(Lingulella) schmalenseei [Obolus], Walcott [1902, p. 605]	Obolus schmalenseei.
(Lingulella) schucherti [Obolus], Walcott [1901, pp. 689–690]	Lingulella schucherti.
Lingulella selwyni Matthew [1895b, pp. 255–256]	Obolus selwyni.
Matthew [1903, pp. 62–63]	Do.
Matthew [1903, pp. 116–123]	Do.
(Lingulella) septalis [Obolus], Walcott [1905a, p. 331]	Obolus septalis.
(Lingulella) siemiradzkii [Obolus], Walcott [1901, pp. 690–691]	Lingulella siemiradzkii.
(Lingulella) similis [Obolus], Walcott [1898b, pp. 415–416]	Lingulella similis.
(Lingulella) sinoe [Obolus], Walcott [1898b, pp. 416–417]	Obolus sinoe.
(Lingulella) spatulus [Obolus], Walcott [1902, p. 607]	Lingulella (Lingulepis) spatula.
Lingulella? spissa Billings [1872b, pp. 468–469]	Obolus (Lingulobolus) spissus.
Billings [1874, pp. 67–68]	Do.
Billings [1882, p. 15]	Do.
Lingulella starri Matthew [1891, pp. 146–147]	Lingulella (Lingulepis) starri.
Lingulella starri minor Matthew [1892, pp. 58–59]	Liugulella minor.
Lingulella stoneana Hall and Clarke [1892c, Pl. II, figs. 9–11]	Obolus (Westonia) stoneanus.
Weller [1903, p. 112]	Do.
Whitfield [1882, pp. 344–345]	Do.
(Lingulella) tarpa [Obolus], Walcott [1898b, pp. 417–418]	Lingulella tarpa.
Lingulella texana Walcott [1908d, p. 71]	Lingulella texana.
Lingulella tumida Matthew [1899b, p. 200]	Lingulella tumida.
Matthew [1903, p. 123]	Do.
Lingulella unguiculus Salter [1866a, p. 285]	Lingulella ferruginea.
(Lingulella) upis [Obolus], Walcott [1905a, pp. 331–332]	Lingulella upis.
Lingulella wanniecki Redlich [1899, p. 7]	Lingulella wanniecki.
(Lingulella) wanniecki [Obolus], Walcott [1905a, p. 332]	Do.
(Lingulella) welleri [Obolus], Walcott [1902, p. 608]	Lingulella welleri.
(Lingulella) willisi [Obolus], Walcott [1898b, pp. 418–419]	Obolus willisi.
Lingulella winona Schuchert [1897, p. 258]	Lingulella winona.
(Lingulella) winona convexus [Obolus], Walcott [1901, p. 691]	Lingulella winona convexa.

	Present reference.
(Lingulella) zetus [Obolus], Walcott [1898b, p. 419]	Obolus zetus.
Lingulella zeus Walcott [new]	Lingulella zeus.
Lingulella sp. Kayser [1883, p. 35]	Obolus? sp. undt. f.
Kayser [1883, pp. 35–36]	Lingulella davisi.
Lingulella sp. [Lingula or], Linnarsson [1876, pp. 15–16]	Doubtfully referred to Lingulella ferruginea.
Lingulella sp. undt. Linnarsson [1879, p. 25]	Lingulella ferruginea.
Lingulella (?) sp. Pompeckj [1896b, p. 509]	Lingulella cf. ferruginea.
Lingulella? sp. No. 1 Wiman [1902, p. 52]	Obolus (Westonia) wimani.
Lingulella? sp. No. 2 Wiman [1902, p. 52]	Do.
Lingulella? sp. No. 3 Wiman [1902, p. 52]	Obolus (Westonia) ålandensis.
Liugulella? sp. No. 4 Wiman [1902, p. 52]	Obolus (Westonia) balticus.
Lingulella? sp. No. 5 Wiman [1902, p. 52]	Obolus (Westonia) ålandensis.
Lingulella? sp. No. 6 Wiman [1902, p. 52]	Obolus (Westonia) balticus.
Lingulella? sp. No. 7 Wiman [1902, p. 52]	Obolus (Westonia) wimani.
Lingulella (Acrothyra?) inflata Matthew [1902b, p. 390]	Acrotreta inflata.
Lingulella (Lingulepis) Walcott [1908e, Pl. XI and pp. 142 and 144]	Lingulella (Lingulepis).
Lingulella (Lingulepis) acuminata sequens Walcott [1908d, p. 72]	Lingulella (Lingulepis) acuminata sequens.
Lingulella (Westonia) ella Grabau and Shimer [1907, p. 193]	Obolus (Westonia) ella.
Lingulepis Dall [1870, pp. 154 and 161]	Lingulella (Lingulepis).
Grabau and Shimer [1907, p. 193]	Do.
Hall [1863, p. 129]	Do.
Hall [1867, p. 106]	Do.
Hall and Clarke [1892a, pp. 231–232]	Do.
Hall and Clarke [1892b, pp. 547–548]	Do.
Hall and Clarke [1892c, pp. 59–62, and 164]	Do.
Matthew [1902c, p. 102]	Do.
Matthew [1903, p. 126]	Do.
Meek [1871, pp. 186–187]	Do.
Meek and Hayden [1865, pp. 1 and 2]	Do.
Schuchert [1897, p. 258]	Do.
Walcott [1897a, p. 404]	Do.
Zittel [1880, p. 664]	Do.
(Lingulepis) [Lingula], Oehlert [1887, p. 1261]	Do.
(Lingulepis) [Lingulella], Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
(Lingulepis) [Obolus], Walcott [1899, pp. 443–444]	Do.
Walcott [1901, p. 683]	Do.
Lingulepis acuminata Dwight [1886, p. 208]	Lingulella (Lingulepis) acuminata.
Matthew [1895b, pp. 257–258]	Do.
Schuchert [1897, p. 259]	Do.
Walcott [1897a, p. 404]	Do.
Lingulepis acuminata meeki Delgado [1904, pp. 366–367]	Lingulella delgadoi.
(Lingulepis) acuminata sequens [Lingulella], Walcott [1908d, p. 72]	Lingulella (Lingulepis) acuminata sequens.
(Lingulepis) acuminatus [Obolus], Walcott [1899, p. 443]	Lingulella (Lingulepis) acuminata.
(Lingulepis) acuminatus meeki [Obolus], Walcott [1899, p. 444]	Lingulella (Lingulepis) acuminata meeki.
Lingulepis acutangulus Schuchert [1897, p. 259]	Lingulella acutangula.
Lingulepis affinis Walcott [1889a, p. 381]	Obolus (Lingulobolus) affinis.
Lingulepis cuneolus Schuchert [1897, p. 259]	Lingulella perattenuata (in part).
Whitfield [1877, pp. 8–9]	Lingulella cuneola.
Whitfield [1880, p. 336]	Do.
Lingulepis ella Hall and Whitfield [1877, p. 232]	Obolus (Westonia) ella.
Walcott [1897a, p. 404]	Do.
(Lingulepis) eros [Obolus], Walcott [1905a, p. 333]	Lingulella (Lingulepis) eros.
Lingulepis gregwa Matthew [1903, pp. 56–57, and 126–131]	Lingulella (Lingulepis) gregwa.
(Lingulepis) gregwa [Obolus], Walcott [1901, pp. 692–694]	Lingulella atava (in part), L. tumida (in part), L. cania (in part), L. (Lingulepis) gregwa (in part), and L. (L.) exigua.
Lingulepis gregwa robusta Matthew [1903, pp. 57 and 131]	Lingulella (Lingulepis) gregwa robusta.
Lingulepis longinervis Matthew [1903, pp. 133–135]	Lingulella (Lingulepis) longinervis.
Lingulepis lusitanica Delgado [1904, pp. 365–366]	Delgadella lusitanica.
Lingulepis mæra Hall and Whitfield [1877, p. 206]	Obolus mæra.
Walcott [1884b, pp. 12–13]	Do.
Lingulepis matinalis Hall [1863, p. 130]	Obolus matinalis.
Hall [1867, p. 107]	Do.

	Present reference.
Lingulepis meeki Walcott [1897a, p. 405]	Lingulella (Lingulepis) acuminata meeki.
Lingulepis minima Dwight [1886, p. 208]	Lingulella (Lingulepis) acuminata.
Whitfield [1884, p. 141]	Do.
Lingulepis? minuta Hall and Whitfield [1877, pp. 206–207]	Linnarssonella minuta.
Walcott [1884b, p. 13]	Linnarssonella minuta (in part).
Lingulepis perattenuatus Whitfield [1877, p. 9]	Lingulella perattenuata.
Whitfield [1880, p. 337]	Do.
Lingulepis pinnaformis Hall [1863, pp. 129–130, Pl. VI, figs. 12 and 13]	Obolus matinalis.
Hall [1863, pp. 129–130, Pl. VI, figs. 14–16]	Lingulella (Lingulepis) acuminata.
Hall [1867, p. 107, Pl. I, figs. 12 and 13]	Obolus matinalis.
Hall [1867, p. 107, Pl. I, figs. 14–16]	Lingulella (Lingulepis) acuminata.
Whitfield [1880, p. 335]	Do.
Whitfield [1882, pp. 169–170]	Do.
Lingulepis pinniformis Dwight [1886, p. 208]	Do.
Grabau and Shimer [1907, p. 193]	Do.
Hall and Clarke [1892a, p. 232]	Do.
Hall and Clarke [1892b, p. 548]	Do.
Hall and Clarke [1892c, p. 60]	Do.
Meek and Hayden [1865, pp. 2–3]	Do.
Schuchert [1897, p. 260]	Do.
Lingulepis prima Grabau and Shimer [1907, p. 193]	Do.
Meek and Hayden [1865, p. 3]	Dicellomus politus.
Miller [1877, p. 115]	Lingulella prima.
Schuchert [1897, p. 260]	Lingulella prima (in part).
(Lingulepis) primus [Obolus], Walcott [1901, p. 673]	Lingulella prima.
Lingulepis pumila Matthew [1903, p. 75]	Lingulella (Lingulepis) pumila.
Lingulepis roberti Matthew [1903, p. 132]	Lingulella (Lingulepis) roberti.
Lingulepis rotunda Matthew [1903, p. 199]	Lingulella rotunda.
(Lingulepis) rowei [Obolus], Walcott [1905a, p. 334]	Lingulella (Lingulepis) rowei.
Lingulepis starri Matthew [1903, p. 195]	Lingulella (Lingulepis) starri.
Lingulepis starri exigua Matthew [1903, pp. 197–198]	Lingulella (Lingulepis) exigua.
Lingulepis starri var. Matthew [1903, pp. 193–197]	Do.
(Lingulepis) sp. undt. [Obolus], Walcott [1906, pp. 567–568]	Lingulella (Lingulepis) sp. undt.
lingulicomes [Tellinomya], McCoy [1854, p. 274]	Lingulella davisi.
Lingulobolus Matthew [1895b, pp. 260–261]	Obolus (Lingulobolus).
(Lingulobolus) [Obolus], Walcott [1901, p. 683]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
Lingulobolus affinis Grabau [1900, pp. 621–622]	Obolus (Lingulobolus) affinis.
Matthew [1895b, pp. 261–262]	Do.
(Lingulobolus) affinis [Obolus], Walcott [1898a, p. 327]	Do.
Lingulobolus affinis cuneata Matthew [1895b, p. 262]	Do.
(Lingulobolus) spissus [Obolus], Walcott [1898a, p. 327]	Obolus (Lingulobolus) spissus.
linguloides [Davidsonella], Waagen [1885a, pp. 764–766]	Neobolus warthi.
linguloides [Lakhmina], Frech [1897, Pl. IA, figs. 4a–b]	Do.
Hall and Clarke [1892a, p. 234]	Do.
Hall and Clarke [1892b, p. 550]	Do.
Hall and Clarke [1892c, p. 28]	Do.
Oehlert [1887, p. 1265]	Do.
Waagen [1891, Pl. II, figs. 3 and 4]	Do.
linguloides [Leptobolus], Matthew [1902b, p. 407]	Lingulella ferruginea.
Matthew [1903, p. 193]	Do.
linguloides [Leptobolus cf.], Matthew [1902b, p. 407]	Do.
Matthew [1903, pp. 192–193]	Do.
linguloides [Lingulella], Matthew [1886, p. 34]	Do.
linguloides [Lingulella cf.], Delgado [1904, pp. 369–370]	Lingulella delgadoi.
Linnarssonella Walcott [1902, pp. 601–602]	Linnarssonella.
Walcott [1908e, Pl. XI, and pp. 142 and 146]	Do.
Linnarssonella broadheadi Walcott [1902, p. 601]	Linnarssonella girtyi.
Linnarssonella girtyi Walcott [1902, pp. 602–603]	Do.
Linnarssonella minuta Walcott [1902, pp. 603–604]	Linnarssonella minuta.
Linnarssonella modesta Walcott [1908d, pp. 90–91]	Linnarssonella modesta.
Linnarssonella nitens Walcott [1908d, p. 91]	Linnarssonella nitens.
Linnarssonella tennesseensis Walcott [1902, pp. 604–605]	Linnarssonella tennesseensis.
Linnarssonella transversa Walcott [1908d, p. 92]	Linnarssonella transversa.

	Present reference.
Linnarssonella urania Walcott [1908d, pp. 92–93]	Linnarssonella urania.
linuarssoni [Obolus (Lingulella)], Walcott [1901, p. 688]	Lingulella linnarssoni.
linnarssoni [Orthis], Kayser [1883, p. 34]	Eoorthis linnarssoni.
linnarssoni [Orthis (Plectorthis)], Walcott [905a, p. 266]	Do.
Linnarssonia Dawson [1890, pp. 53–54]	Acrotreta.
Grabau and Shimer [1907, p. 200]	Either Acrotreta or Acrothele. (See p. 631.)
Hall and Clarke [1892a, p. 251]	Acrotreta.
Hall and Clarke [1892b, p. 567]	Do.
Hall and Clarke [1892c, pp. 107 and 109]	Do.
Matthew [1886, p. 35]	Do.
Matthew [1892, p. 42]	Do.
Walcott [1885a, p. 115]	Do.
Linnarssonia belti Matley [1902, p. 145]	Acrotreta belti.
Linnarssonia belti? Matthew [1892, pp. 42–43]	(?) This species is not specifically referred in this monograph; it does not belong with Acrotreta belti.
Linnarssonia cf. belti Matthew [1903, pp. 209–210]	(?) This species is not specifically referred in this monograph; it does not belong with Acrotreta belti.
Linnarssonia belti magna Matthew [1897b, pp. 169–170]	Acrotreta sagittalis magna.
Linnarssonia misera Hall and Clarke [1892c, pp. 108–109]	Acrotreta misera.
Matthew [1886, pp. 35–36]	Do.
Linnarssonia? nitida Walcott [1901, p. 673]	Acrothele nitida.
Linnarssonia pretiosa Grabau and Shimer [1907, p. 200]	Either Acrotreta sagittalis or Acrothele pretiosa. (See p. 652.)
Hall and Clarke [1892c, p. 70]	Acrotreta sagittalis.
Schuchert [1897, p. 262]	Acrotreta sagittalis (in part) and Acrothele pretiosa (in part).
Walcott [1901, p. 673]	Acrothele pretiosa.
Linnarssonia cf. pretiosa Hall [1890, p. 55]	Acrotreta sagittalis.
(Linnarssonia) pretiosa [Obolella], Dawson [1890, pp. 53–54]	Do.
Linnarssonia sagittalis Frech [1897, Pl. IA, fig. 3a]	Do.
Hall and Clarke [1892c, p. 108]	Do.
Walcott [1885a, p. 115]	Do.
Walcott [1889c, p. 442]	Acrotreta depressa.
Walcott [1891a, Pl. LXVIII, figs. 2a–d]	Acrotreta sagittalis.
Linnarssonia sagittalis taconica Walcott [1889b, p. 36]	Acrotreta sagittalis taconica.
Walcott [1891a, pp. 610–611]	Do.
Linnarssonia sagittalis transversa Frech [1897, Pl. IA, fig. 3b]	Acrotreta sagittalis transversa.
Walcott [1891a, desc. of Pl. LXVIII, figs. 2a, 2c–d]	Do.
Linnarssonia taconica Oehlert [1889, p. 1138]	Acrotreta sagittalis taconica.
Walcott [1887, pp. 189–190]	Do.
Linnarssonia transversa Hall and Clarke [1892a, Pl. III, figs. 22 and 23]	Acrotreta sagittalis transversa.
Hall and Clarke [1892c, p. 108]	Do.
Matthew [1886, p. 35]	Do.
Matthew [1895a, p. 125]	Do.
Walcott [1885a, p. 115]	Do.
logani [Iphidea], Walcott [1897b, pp. 711–712]	Micromitra (Paterina) logani.
longinervis [Lingulepis], Matthew [1903, pp. 133–135]	Lingulella (Lingulepis) longinervis.
longovalis [Lingulella], Matthew [1903, pp. 123–125]	Lingulella triparilis.
longus [Obolus (Palæobolus) lens], Matthew [1903, pp. 146–147]	Obolus (Palæobolus) bretonensis lens.
longus [Obolus (Schmidtia) obtusus], Mickwitz [1896, pp. 171–172]	Obolus (Schmidtia) obtusus.
loperi [Obolus], Walcott [1898b, pp. 389–390]	Obolus loperi.
(Loperia) [Protorthis], Walcott [1905a, p. 287]	Protorthis (Loperia).
Walcott [1908e, Pl. XI, and pp. 142 and 147]	Do.
(Loperia) dougaldensis [Protorthis], Walcott [1905a, pp. 287–288]	Protorthis (Loperia) dugaldensis.
louise [Micromitra (Iphidella)], Walcott [1908d, pp. 56–57]	Micromitra (Iphidella) louise.
lowi (Nisusia Jamesella), Walcott [1908d, p. 98]	Nisusia (Jamesella) lowi.
(Lucina) antiquissimus [Obolus], Eichwald [1843b, pp. 142–144]	Obolus (Acritis) antiquissimus.
lusitanica [Lingulepis], Delgado [1904, pp. 365–366]	Delgadella lusitanica.
lyncioides [Orthis lenticularis], Matthew [1892, p. 49]	Orusia lenticularis lyncioides.
Matthew [1903, p. 216]	Do.
lyncioides [Orthis (Orusia) lenticularis], Walcott [1905a, p. 277]	Do.

M.

	Present reference.
mcconnelli [Lingulella], Matthew [1902c, p. 108]	Obolus mcconnelli.
Walcott [1889c, p. 441]	Do.
mcconnelli [Obolus], Walcott [1908c, Pl. I, fig. 2]	Do.
Walcott [1908c, Pl. I, fig. 2a]	Obolus septalis.
mcconnelli decipiens [Obolus], Walcott [new]	Obolus mcconnelli decipiens.
macra [Nisusia (Jamesella) perpasta], Walcott [1905a, p. 255]	Nisusia (Jamesella) perpasta macra.
macra [Orthis perpasta], Pompeckj [1896b, p. 516]	Do.
maculata [Obolella], Davidson [1868, p. 311]	Acrothele maculata.
Davidson [1871, p. 341]	Do.
Delgado [1904, p. 364]	Acrothele villaboimensis.
Salter [1866a, p. 285]	Acrothele maculata.
mæra [Lingulella?], Hall and Clarke [1892c, p. 61]	Obolus mæra.
Walcott [1897a, p. 404]	Do.
mæra [Lingulepis], Hall and Whitfield [1877, p. 206]	Do.
Walcott [1884b, pp. 12–13]	Do.
mæra [Obolus (Lingulella)], Walcott [1899, p. 443]	Do.
magna [Acrotreta sagittalis], Walcott [1902, pp. 595–596]	Acrotreta sagittalis magna.
magna [Linnarssonia belti], Matthew [1897b, pp. 169–170]	Do.
major [Billingsella], Walcott [1905a, p. 239]	Billingsella major.
Walcott [1908d, p. 101]	Do.
major [Iphidella], Walcott [1905a, p. 304]	Micromitra (Paterina) major (in part) and M. (P.) williardi (in part).
major [Mickwitzia?], Mickwitz [1896, p. 23]	Rustella? major.
major [Obolus?], Matthew [1890, p. 155]	Do.
maladensis [Iphidella pannula], Walcott [1905a, p. 306]	Micromitra (Iphidella) pannula maladensis.
malvernensis [Acrotreta (?) sabrinæ], Matley [1902, pp. 143–144]	Acrotreta sabrinæ.
manitouensis [Schizambon], Walcott [new]	Schizambon manitouensis.
manticula [Lingula?], Walcott [1884b, pp. 13–14]	Lingulella punctata.
White [1874, pp. 9–10]	Lingulella arguta (in part) and L. manticula (in part).
White [1877, pp. 52–53, Pl. III, fig. 2a]	Lingulella arguta. The text also includes L. manticula.
White [1877, p. 52, Pl. III, fig. 2b]	Lingulella manticula. The text includes L. arguta.
marion [Billingsella], Walcott [1908d, p. 102]	Billingsella marion.
marjumensis [Acrotreta], Walcott [1908d, pp. 94–95]	Acrotreta marjumensis.
martinensis [Lingulella], Matthew [1890, pp. 155–156]	Lingulella martinensis.
Matthew [1895a, pp. 113–114]	Do.
matinalis [Lingulella?], Walcott [1897a, p. 404]	Obolus matinalis.
matinalis [Lingulepis], Hall [1863, p. 130]	Do.
Hall [1867, p. 107]	Do.
matinalis? [Obolus], Walcott [1905a, p. 325]	Obolus matinalis?.
matinalis [Obolus (Lingulella)], Walcott [1899, p. 443]	Obolus matinalis.
matthewi [Acrothele], Grabau and Shimer [1907, p. 200, fig. 234f]	Acrothele matthewi.
Grabau and Shimer [1907, p. 200, fig. 234g]	Acrothele prima.
Hall and Clarke [1892a, Pl. III, fig. 24]	Acrothele matthewi.
Hall and Clarke [1892c, pp. 99 and 100]	Do.
Matthew [1886, pp. 39–41]	Do.
Matthew [1895a, p. 128]	Do.
Matthew [1902b, pp. 397 and 402]	Do.
Matthew [1903, p. 104]	Do.
Walcott [1884a, p. 15]	Do.
Walcott [1886b, p. 109]	Do.
Walcott [1891a, p. 609]	Do.
matthewi [Lingula], Hartt [1868, p. 644]	Do.
Hartt [1878, p. 644]	Do.
Hartt [1891, p. 644]	Do.
matthewi costata [Acrothele], Matthew [1895a, p. 128]	Acrothele prima costata.
Matthew [1902b, p. 397]	Do.
Matthew [1903, p. 104]	Do.
matthewi eryx [Acrothele], Walcott [1905b, p. 11]	Acrothele matthewi eryx.

	Present reference.
matthewi lata [Acrothele], Hall and Clarke [1892a, Pl. III, figs. 25 and 26]	Acrothele matthewi lata.
Hall and Clarke [1892c, Pl. III, figs. 26–28]	Do.
Matthew [1886, p. 41]	Do.
Matthew [1895a, Pl. V, figs. 8a–b]	Do.
Matthew [1903, p. 104]	Do.
matthewi multicostata [Acrothele], Matthew [1897b, p. 168]	Acrothele matthewi multicostata.
matthewi prima [Acrothele], Hall and Clarke [1892a, Pl. III, fig. 27]	Acrothele prima.
Hall and Clarke [1892c, Pl. III, fig. 25]	Do.
Matthew [1886, p. 41]	Do.
Matthew [1895a, Pl. V, figs. 7a–b]	Do.
Matthew [1902b, pp. 397 and 402]	Do.
Matthew [1903, p. 104]	Do.
maximus [Obolus apollinis], Mickwitz [1896, pp. 140–143]	Obolus apollinis maximus.
meeki [Lingulepis], Walcott [1897a, p. 405]	Lingulella (Lingulepis) acuminata meeki.
meeki [Lingulepis acuminata], Delgado [1904, pp. 366–367]	Lingulella delgadoi.
meeki [Obolus (Lingulepis) acuminatus], Walcott [1899, p. 444]	Lingulella (Lingulepis) acuminata meeki.
Meekina prima Walcott [1905a, p. 313]	Linnarssonella tennesseensis.
melita [Dalmanella], Schuchert [1897, p. 202]	Variety of Eoorthis desmopleura.
melita [Leptæna], Hall and Whitfield [1877, p. 208]	Do.
membranaceous [Obolus], Walcott [1908d, p. 61]	Obolus membranaceus.
meneghini [Obolus (?)], Walcott [1901, p. 684]	Obolus? meneghinii.
Metoptoma sabrinæ Callaway [1874, p. 196]	Acrotreta sabrinæ.
(Mickwitzella) [Obolus], Walcott [1908d, p. 70]	Obolus (Mickwitzella).
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
mickwitzi [Obolus], Walcott [1898b, pp. 386–387]	Obolus mickwitzi.
Mickwitzia Hall and Clarke [1892a, p. 246]	Mickwitzia.
Hall and Clarke [1892b, p. 562]	Do.
Hall and Clarke [1892c, pp. 86–87]	Do.
Schmidt [1888, p. 24]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 143]	Do.
Mickwitzia? major Mickwitz [1896, p. 23]	Rustella? major.
Mickwitzia monilifera Hall and Clarke [1892a, figs. 253–255, p. 246]	Mickwitzia monilifera.
Hall and Clarke [1892b, figs. 253–255, p. 562]	Do.
Hall and Clarke [1892c, p. 86]	Do.
Schmidt [1888, pp. 21–23 and 24–25]	Do.
Walcott [1891a, Pl. LXX, figs. 2, 2a–h]	Do.
Wiman [1902, p. 53]	Do.
Mickwitzia occidens Walcott [1908d, p. 54]	Mickwitzia occidens.
Mickwitzia pretiosa Walcott [1908d, pp. 54–55]	Mickwitzia pretiosa.
Micromitra Meek [1873, p. 479]	Micromitra.
Walcott [1908e, Pl. XI, and pp. 142 and 143]	Do.
(Micromitra) [Paterina], Schuchert [1905, p. 329]	Do.
Micromitra haydeni Walcott [1908d, pp. 55–56]	Micromitra haydeni.
Micromitra scotica Walcott [new]	Micromitra scotica.
Micromitra sculptilis endlichi Walcott [1908d, p. 56]	Micromitra sculptilis endlichi.
Micromitra zenobia Walcott [new]	Micromitra zenobia.
Micromitra (Iphidella) Walcott [1908e, Pl. XI, and pp. 142 and 143]	Micromitra (Iphidella).
Micromitra (Iphidella) louise Walcott [1908d, pp. 56–57]	Micromitra (Iphidella) louise.
Micromitra (Iphidella) nyssa Walcott [1908d, p. 57]	Micromitra (Iphidella) nyssa.
Micromitra (Iphidella) pannula Walcott [1908c, p. 244, Pl. I, figs. 1, 1a–c]	Micromitra (Iphidella) pannula.
Micromitra (Paterina) Walcott [1908e, Pl. XI, and pp. 142 and 143]	Micromitra (Paterina).
Micromitra (Paterina) labradorica var. undt. Walcott [new]	Micromitra (Paterina) labradorica var. undt.
Micromitra (Paterina) stissingensis ora Walcott [new]	Micromitra (Paterina) stissingensis ora.
Micromitra (Paterina) stuarti Walcott [1908d, p. 58]	Micromitra (Paterina) stuarti.
Micromitra (Paterina) wapta Walcott [1908d, p. 59]	Micromitra (Paterina) wapta.
Micromitra (Paterina) williardi Walcott [1908d, p. 60]	Micromitra (Paterina) williardi.
microscopica [Discina], Shumard [1861, p. 221]	Acrotreta microscopica.
microscopica missouriensis [Acrotreta], Walcott [1902, p. 590]	Acrotreta microscopica missouriensis.
microscopica tetonensis [Acrotreta], Walcott [1902, p. 590]	Acrotreta microscopica tetonensis.
minima [Lingulepis], Dwight [1886, p. 208]	Lingulella (Lingulepis) acuminata.
Whitfield [1884, p. 141]	Do.
minimus [Obolus?], Barrande [1879b, Pl. XCV, figs. II: 1–5]	Acrotreta? minima.
minimus [Obolus], Walcott [1905a, pp. 325–326]	Obolus minimus.

	Present reference.
minimus [Obolus (Lingulella) lamborni], Walcott [1898b, p. 407]	Obolus lamborni minimus.
minor [Acrothyra], Walcott [1905a, p. 303]	Acrothyra minor.
minor [Camarella], Hall and Clarke [1893b, p. 221]	Obolella minor.
minor [Camarella?], Walcott [1891a, p. 614]	Do.
minor [Camerella], Walcott [1890b, pp. 36–37]	Do.
minor [Lingulella starri], Matthew [1892, pp. 58–59]	Lingulella minor.
minor [Obolella], Clark and Mathews [1906, p. 252]	Obolella minor.
minor [Obolus?], Barrande [1868a, p. 105]	Obolus? minor.
Barrande [1868b, p. 693]	Do.
minor [Protorhyncha?], Schuchert [1897, p. 334]	Obolella minor.
minuta [Acrothele?], Walcott [1905a, p. 303]	Acrothele? minuta.
minuta [Acrotreta], Walcott [1901, p. 673]	Linnarssonella minuta.
minuta [Lingulella], Schuchert [1897, p. 257]	Do.
minuta [Lingulepis?], Hall and Whitfield [1877, pp. 206–207]	Do.
Walcott [1884b, p. 13]	Linnarssonella minuta (in part).
minuta [Linnarssonella], Walcott [1902, pp. 603–604]	Linnarssonella minuta.
minuta [Obolella?], Walcott [1897a, p. 404]	Do.
minuta [Obolella], Walcott [1899, p. 443]	Do.
minutissima [Kutorgina], Hall and Whitfield [1877, pp. 207–208]	Micromitra sculptilis.
minutus [Obolus (Schmidtia) obtusus], Mickwitz [1896, pp. 175–177]	Obolus (Schmidtia) obtusus.
miqueli [Yorkia], Walcott [new]	Yorkia miqueli.
miranda [Lingula?], Barrande [1879b, Pl. CXI]	Obolus? mirandus.
miser [Acrotreta], Walcott [1902, pp. 590–591]	Acrotreta misera.
miser [Obolella?], Billings [1872b, pp. 470–471]	Do.
Billings [1874, p. 69]	Do.
misera [Linnarssonia], Hall and Clarke [1892c, pp. 108 and 109]	Do.
Matthew [1886, pp. 35–36]	Do.
missouriensis [Acrotreta microscopica], Walcott [1902, p. 590]	Acrotreta microscopica missouriensis.
mobergi [Obolella], Walcott [1901, pp. 673–674]	Obolella mobergi.
Mobergia Redlich [1899, pp. 5–6]	Botsfordia.
Mobergia granulata Redlich [1899, pp. 5–6]	Botsfordia granulata.
modesta [Linnarssonella], Walcott [1908d, pp. 90–91]	Linnarssonella modesta.
Monobolina refulgens Matthew [1903, pp. 210–213]	Obolus refulgeus.
(Monobolina) refulgens [Obolus], Matthew [1902c, p. 98]	Do.
monilifer [Obolus?], Linnarsson [1871, pp. 9–10]	Mickwitzia monilifera.
monilifera [Lingula?], Linnarsson [1869a, p. 344]	Do.
monilifera [Lingula], Linnarsson [1869b, p. 398]	Do.
monilifera [Mickwitzia], Hall and Clarke [1892a, figs. 253–255, p. 246]	Do.
Hall and Clarke [1892b, figs. 253–255, p. 562]	Do.
Hall and Clarke [1892c, p. 86]	Do.
Schmidt [1888, pp. 21–23 and 24–25]	Do.
Walcott [1891a, Pl. LXX, figs. 2, 2a–h]	Do.
Wiman [1902, p. 53]	Do.
montanensis [Polytœchia?], Walcott [1905a, pp. 295–296]	Clarkella? montanensis.
mosia [Lingula], Hall [1863, p. 126]	Lingulella mosia.
Hall [1867, pp. 102–103]	Do.
Sardeson [1896, p. 95]	Do.
mosia osceola [Obolus (Lingulella)], Walcott [1898b, p. 409]	Lingulella mosia osceola.
multicostata [Acrothele matthewi], Matthew [1897b, p. 168]	Acrothele matthewi multicostata.
murrayi [Obolus?], Billings [1865b, p. 362]	Obolus? murrayi.

N.

namouna [Obolus], Walcott [1898b, p. 390]	Obolus namouna.
nana [Obolella], Billings [1862d, pp. 67–68]	Dicellomus nanus.
Hall and Clarke [1892c, pp. 69–70]	Do.
Hayden [1862, p. 73]	Do.
Meek and Hayden [1862, pp. 435–436]	Do.
Meek and Hayden [1865, p. 4]	Do.
Walcott [1886b, p. 111]	Do.
Whitfield [1880, pp. 340–341]	Do.
nanno [Obolus (Lingulella)], Walcott [1898b, p. 409]	Lingulella nanno.

	Present reference.
nanus [Dicellomus], Walcott [1899, p. 447]	Lingulella desiderata (in part) and Dicellomus nanus (in part).
Walcott [1905a, pp. 314–315]	Dicellomus nanus.
nathorsti [Lingulella?], Linnarsson [1876, pp. 15–16]	Lingulella nathorsti.
nautes [Protorthis], Walcott [1905a, pp. 283–284]	Nisusia (Jamesella) nautes.
neboensis [Acrotreta], Walcott [1905a, pp. 300–301]	Acrotreta neboensis.
nebulosa [Genre? sp.], Barrande [1868a, pp. 105–106]	Orbiculoidea contraria.
Barrande [1868b, pp. 693–694]	Do.
Neobolus Hall and Clarke [1892a, p. 245]	Neobolus.
Hall and Clarke [1892b, p. 561]	Do.
Hall and Clarke [1892c, p. 84]	Do.
Oehlert [1887, p. 1263]	Do.
Waagen [1885, pp. 756–758]	Do.
Walcott [1908d, pp. 72–76]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
Neobolus warthi Frech [1897, Pl. IA, figs. 5a–b]	Neobolus warthi.
Hall and Clarke [1892a, p. 245]	Do.
Hall and Clarke [1892b, p. 561]	Do.
Hall and Clarke [1892c, p. 84]	Do.
Oehlert [1887, p. 1263]	Do.
Waagen [1885, pp. 758–759]	Do.
Waagen [1891, Pl. II, figs. 5–9]	Do.
Neobolus wynnei Waagen [1885, pp. 759–761]	Do.
Waagen [1891, Pl. II, figs. 10 and 11]	Do.
newberryi [Eoorthis], Walcott [1908d, p. 105]	Eoorthis newberryi.
newtonensis [Orthis], Weller [1903, pp. 113–114]	Eoorthis newtonensis.
newtonensis [Orthis (Plectorthis)], Walcott [1905a, p. 267]	Do.
nicholsoni [Acrotreta?], Davidson [1868, pp. 313–314]	Acrotreta nicholsoni.
Davidson [1871, pp. 343–344]	Do.
nicholsoni [Acrotreta], Davidson [1883, p. 213]	Do.
Hall and Clarke [1892c, p. 103]	Do.
Swanston [1877, Pl. VII, figs. 21a–c]	Do.
Swanston [1886, Pl. VII, figs. 21a–c]	Do.
nicholsoni [Acrotreta sp. cf.], Matley [1902, p. 142]	Acrotreta sabrinæ.
nicholsoni [Lingulella], Callaway [1874, p. 196]	Lingulella nicholsoni.
Callaway [1877, pp. 668–669]	Do.
Davidson [1883, pp. 208–209]	Do.
nicholsoni? [Lingulella], Matley [1902, p. 141]	Do.
ninus [Obolus tetonensis], Walcott [1905a, p. 328]	Obolus tetonensis ninus.
nisus [Iphidella], Walcott [1905a, p. 305]	Micromitra nisus.
Nisusia Grabau and Shimer [1907, p. 210]	Nisusia.
Walcott [1905a, pp. 247–248]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 147]	Do.
Nisusia alberta Walcott [1905a, pp. 248–249]	Nisusia alberta.
Walcott [1908c, p. 245]	Do.
Nisusia festinata Grabau and Shimer [1907, p. 211]	Nisusia festinata.
Walcott [1905a, pp. 249–251]	Do.
Nisusia festinata transversa Walcott [1905a, p. 251]	Nisusia festinata transversa.
Nisusia rara Walcott [1908d, p. 97]	Nisusia rara.
Nisusia (Jamesella) Walcott [1905a, p. 252]	Nisusia (Jamesella).
Walcott [1908e, Pl. XI, and pp. 142 and 147]	Do.
Nisusia (Jamesella) amii Walcott [1905a, p. 252]	Nisusia (Jamesella) amii.
Nisusia (Jamesella) argenta Walcott [1905a, p. 252]	Nisusia (Jamesella) argenta.
Nisusia (Jamesella) erecta Walcott [1905a, p. 253]	Nisusia (Jamesella) erecta.
Nisusia? (Jamesella?) kanabensis Walcott [1908d, pp. 97–98]	Nisusia? (Jamesella?) kanabensis.
Nisusia (Jamesella) kuthani Walcott [1905a, pp. 253–254]	Nisusia (Jamesella) kuthani.
Nisusia (Jamesella) lowi Walcott [1908d, p. 98]	Nisusia (Jamesella) lowi.
Nisusia (Jamesella) perpasta Walcott [1905a, pp. 254–255]	Nisusia (Jamesella) perpasta.
Nisusia (Jamesella) perpasta macra Walcott [1905a, p. 255]	Nisusia (Jamesella) perpasta macra.
Nisusia (Jamesella) perpasta subquadrata Walcott [1905a, p. 255]	Nisusia (Jamesella) perpasta subquadrata.
Nisusia (Jamesella) utahensis Walcott [1905a, pp. 255–256]	Nisusia (Jamesella) utahensis.
Nisusia (Jamesella) sp. undt. Walcott [1905a, p. 256]	Nisusia (Jamesella) sp. undt.
nitens [Linnarssonella], Walcott [1908d, p. 91]	Linnarssonella nitens.
nitida [Linnarssonia?], Walcott [1901, p. 673]	Acrothele nitida.

	Present reference.
nitida [Obolella], Ford [1873, p. 213]	Acrothele nitida.
Grabau and Shimer [1907, p. 189]	Do.
Hall and Clarke [1892c, p. 70]	Do.
Walcott [1886b, pp. 118–119]	Do.
Walcott [1891a, p. 612]	Do.
notchensis [Obolus (Westonia)], Walcott [1908d, p. 69]	Obolus (Westonia) notchensis.
nox [Acrotreta], Walcott [1905a, p. 301]	Acrotreta nox.
nundina [Obolus], Walcott [1905a, p. 326]	Obolus nundina.
nundina [Syntrophia], Walcott [1905a, p. 292]	Syntrophia nundina.
nunnebergensis [Protorthis?], Walcott [1905a, p. 284]	Protorthis? hunnebergensis.
nympha [Orthis (Plectorthis) desmopleura], Walcott [1905a, p. 262]	Eoorthis desmopleura nympha.
nyssa [Micromitra (Iphidella)], Walcott [1908d, p. 57]	Micromitra (Iphidella) nyssa.

O.

Obolella Billings [1861b, p. 7]	Obolella.
Billings [1861c, p. 946]	Do.
Billings [1862c, pp. 420–421]	Do.
Billings [1862e, p. 218]	Do.
Billings [1872a, pp. 217–218]	Do.
Billings [1872c, pp. 355–357]	Do.
Billings [1876, pp. 176–178]	Do.
Dall [1870, pp. 154 and 163]	Do.
Davidson [1866, p. 60]	Do.
Davidson [1868, pp. 308–309]	Do.
Davidson [1871, pp. 338–339]	Do.
Ford [1881, pp. 131–134]	Do.
Grabau and Shimer [1907, p. 188]	Do.
Hall [1863, p. 131]	Do.
Hall [1867, p. 108]	Do.
Hall and Clarke [1892a, pp. 240–241]	Obolella (in part) and Dicellomus (in part).
Hall and Clarke [1892b, pp. 556–557]	Do.
Hall and Clarke [1892c, pp. 66–73 and 164–165]	Obolella (in part), Dicellomus (in part), Bicia (in part), Obolus (in part), etc.
Matthew [1892, pp. 39–40]	Obolella.
Meek and Hayden [1865, pp. 3–4]	Do.
Mickwitz [1896, pp. 116, 121, and 123–126]	Do.
Oehlert [1887, p. 1262]	Do.
Obolella? Walcott [1884b, pp. 67–68]	Do.
Obolella Walcott [1886b, pp. 109–112]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 145]	Do.
Zittel [1880, p. 664]	Do.
Obolella? ambigua Walcott [1884b, pp. 67–68]	Elkania ambigua.
Obolella asiatica Walcott [1905a, p. 297]	Obolella asiatica.
Obolella atlantica Burr [1900, p. 47]	Obolella atlantica.
Gorham [1905, Pl. I, figs. 2a–c]	Do.
Grabau [1900, pp. 620–621]	Do.
Grabau and Shimer [1907, p. 188]	Do.
Matthew [1899d, p. 70]	Do.
Walcott [1890b, p. 36]	Do.
Walcott [1891a, p. 611]	Do.
Obolella cf. atlantica Delgado [1904, p. 364]	Obolella? sp. indt.
Obolella belti Davidson [1868, pp. 310–311]	Acrotreta belti.
Davidson [1871, pp. 340–341]	Do.
Obolella cælata Billings [1872a, p. 218]	Botsfordia cælata.
Obolella chromatica Billings [1861b, pp. 7–8]	Obolella chromatica.
Billings [1861c, p. 947]	Do.
Billings [1862e, p. 219]	Do.
Billings [1863, p. 284]	Do.
Billings [1876, pp. 176–178]	Do.
Ford [1881, p. 133]	Do.
Hall [1863, p. 132]	Do.
Hall [1867, p. 110]	Do.
Hall and Clarke [1892c, p. 67]	Do.
von Toll [1899, p. 27]	(?) (See p. 592.)

	Present reference.
Obolella chromatica Walcott [1885a, pp. 115 and 117]	Obolella crassa.
Walcott [1886b, p. 112]	Obolella chromatica.
Walcott [1891a, p. 611]	Do.
Walcott [1899, p. 446]	Do
Walcott [1905a, p. 313]	Do.
Obolella cingulata Billings [1863, p. 284, figs. 287a–b]	Kutorgina cingulata.
Billings [1863, p. 284, fig. 287c]	Rustella edsoni.
Obolella circe Billings [1872a, pp. 219–220]	Quebecia circe.
Billings [1872c, pp. 357–358]	Do.
Walcott [1886b, p. 118, Pl. X, fig. 3]	Obolella chromatica. The text includes Quebecia circe.
Walcott [1886b, p. 118, Pl. X, fig. 3a]	Quebecia circe.
Walcott [1891a, p. 611, Pl. LXXI, fig. 3]	Obolella chromatica. The text includes Quebecia circe.
Walcott [1891a, p. 611, Pl. LXXI, fig. 3a]	Quebecia circe.
Obolella circe? Walcott [1891a, fig. 62, p. 611]	Obolella crassa.
Obolella?? complexus Hall and Clarke [1892c, p. 73]	Obolus complexus.
Obolella crassa Billings [1872a, p. 218]	Obolella crassa.
Billings [1872c, p. 356]	Do.
Bornemann [1891, pp. 439–440]	Obolus? zoppi.
Ford [1878, p. 128]	Obolella crassa.
Ford [1881, pp. 131–133]	Do.
Ford [1886a, fig. 2, p. 466]	Do.
Gorham [1905, Pl. I, figs. 1a–f]	Obolella atlantica.
Grabau and Shimer [1907a, pp. 188–189]	Obolella crassa.
Hall and Clarke [1892a, Pl. III, figs. 5–7]	Do.
Hall and Clarke [1892c, p. 70]	Do.
Shaler and Foerste [1888, p. 27]	Obolella atlantica.
Walcott [1885b, p. 21]	Obolella crassa.
Walcott [1886b, p. 114]	Do.
Walcott [1891a, p. 612]	Do.
Walcott [1905a, p. 321]	Do.
Obolella crassa? Grabau [1900, pp. 619–620]	Do.
Obolella crassa elongata Walcott [new]	Obolella crassa elongata.
Obolella desiderata Billings [1862d, pp. 69–70]	Elkania desiderata.
Davidson [1868, p. 309]	Do.
Obolella? desiderata Walcott [1886b, p. 111]	Do.
Obolella desquamata Billings [1872a, p. 218]	Obolella crassa.
Billings [1872c, p. 356]	Do.
Obolella discoida Hall and Whitfield [1877, p. 205]	Obolus discoideus.
Obolella? discoidea Hall and Clarke [1892c, p. 69]	Do.
Obolella discoidea Walcott [1884b, p. 14]	Do.
Obolella? discoidea Walcott [1886b, p. 111]	Do.
Obolella gamagei Hobbs [1899, pp. 114–115]	Acrothele gamagei.
Obolella gemma Billings [1872a, pp. 218–219]	Bicia gemma.
Billings [1872c, p. 355]	Do.
Hall and Clarke [1892c, pp. 69 and 71]	Do.
Walcott [1886b, pp. 116–117]	Do.
Walcott [1891a, p. 612]	Do.
Obolella? gemmula Matthew [1892, pp. 41–42]	Lingulella ferruginea.
Obolella (?) groomi Matley [1902, pp. 137 and 139]	Obolella groomi.
Obolella ida Billings [1862d, p. 71]	Elkania ida.
Obolella ida? Dawson [1888a, p. 55]	Acrotreta sagittalis.
Dawson [1888b, p. 55]	Do.
Obolella? ida Walcott [1886b, p. 111]	Elkania ida.
Obolella lindströmi Walcott [1901, pp. 674–675]	Obolella? lindströmi.
Obolella maculata Davidson [1868, p. 311]	Acrothele maculata.
Davidson [1871, p. 341]	Do.
Delgado [1904, p. 364]	Acrothele villaboimensis.
Salter [1866a, p. 285]	Acrothele maculata.
Obolella minor Clark and Mathews [1906, p. 252]	Obolella minor.
Obolella minuta Walcott [1899, p. 443]	Linnarssonella minuta.
Obolella? minuta Walcott [1897a, p. 404]	Do.

	Present reference.
Obolella? miser Billings [1872b, pp. 470–471]	Acrotreta misera.
Billings [1874, p. 69]	Do.
Obolella mobergi Walcott [1901, pp. 673–674]	Obolella mobergi.
Obolella nana Billings [1862d, pp. 67–68]	Dicellomus nanus.
Hall and Clarke [1892c, pp. 69–70]	Do.
Hayden [1862, p. 73]	Do.
Meek and Hayden [1862, pp. 435–436]	Do.
Meek and Hayden [1865, p. 4]	Do.
Walcott [1886b, p. 111]	Do.
Whitfield [1880, pp. 340–341]	Do.
Obolella nitida Ford [1873, p. 213]	Acrothele nitida.
Grabau and Shimer [1907, p. 189]	Do.
Hall and Clarke [1892c, p. 70]	Do.
Walcott [1886b, pp. 118–119]	Do.
Walcott [1891a, p. 612]	Do.
Obolella parvula Wallerius [1895, pp. 65–66]	Acrotreta parvula.
Obolella pectenoides Schuchert [1897, p. 275]	Dicellomus pectenoides.
Obolella? phillipsi Davidson [1866, pp. 62–63]	Micromitra (Paterina) phillipsi.
Obolella phillipsi Holl [1865, p. 102]	Do.
Phillips [1871, p. 68]	Do.
Obolella phillipsia Dall [1877, p. 41]	Do.
Obolella polita Billings [1862c, p. 421]	Dicellomus politus.
Obolella? polita Hall [1863, pp. 133–134]	Do.
Hall [1867, pp. 112–113]	Do.
Obolella polita Hall and Clarke [1892c, pp. 72 and 73]	Do.
Walcott [1886b, p. 111]	Do.
Whitfield [1880, pp. 339–340]	Do.
Obolella pretiosa Billings [1862d, pp. 68–69]	Acrothele pretiosa.
Billings [1863, p. 230]	Do.
Chapman [1863, p. 191]	Do.
Chapman [1864, p. 163]	Do.
Obolella? pretiosa Walcott [1886b, p. 111]	Do.
Obolella prima Whitfield [1884, pp. 142–143]	Lingulella prima.
Obolella sabrinæ Callaway [1877, p. 669]	Acrotreta sabrinæ.
Davidson [1883, p. 211]	Do.
Hall and Clarke [1892c, p. 103]	Do.
Obolella sagittalis Brögger [1882, p. 45]	Acrotreta sagittalis.
Davidson [1868, pp. 309–310]	Do.
Davidson [1871, pp. 339–340]	Do.
Davidson [1883, p. 211]	Do.
Linnarsson [1876, pp. 19–20]	Do.
Linnarsson [1879, pp. 27–28]	Do.
Salter [1866a, p. 285]	Do.
Obolella cf. sagittalis Wiman [1902, p. 66]	Do.
Obolella sagittalis belti Davidson [1871, desc. of Pl. L, figs. 15–17]	Acrotreta belti.
Obolella? salteri Davidson [1868, p. 311]	Obolus (Bröggeria) salteri.
Obolella salteri Holl [1865, p. 102]	Do.
Obolella (?) salteri Matley [1902, pp. 139–140]	Do.
Obolella salteri Phillips [1871, p. 68]	Do.
Obolella salteri? Davidson [1866, pp. 61–62]	Do.
Obolella? scabrinæ Walcott [1884b, Pl. I, fig. 1c]	Acrotreta sabrinæ.
Obolella transversa Hartt [1868, p. 644]	Acrotreta sagittalis transversa.
Hartt [1878, p. 644]	Do.
Hartt [1891, p. 644]	Do.
Walcott [1884a, p. 16]	Do.
Obolella vermilionensis Walcott [new]	Obolella vermilionensis.
Obolella wirrialpensis Etheridge [1905, p. 248]	Obolella wirrialpensis.
Obolella wirrialpensis calceoloides Etheridge [1905, p. 249]	Do.
Obolella sp. 3 Billings [1861b, p. 7]	Dicellomus politus.
Billings [1861c, p. 946]	Do.
Billings [1862e, p. 218]	Do.
Obolella sp. (?) Bornemann [1891, p. 440]	Obolus? meneghinii.
Obolella sp. Shaler and Foerste [1888, pp. 27–28]	Obolella atlantica.

	Present reference.
Obolella (Acrotreta?) sagittalis Moberg and Segerberg [1906, p. 64]	Acrotreta sagittalis.
Obolella (Glyptias) Walcott [1901, p. 675]	Obolella (Glyptias).
Walcott [1908e, Pl. XI, and pp. 142 and 145]	Do.
Obolella (Glyptias) favosa Walcott [1901, pp. 675–676]	Obolella (Glyptias) favosa.
Obolella (Kutorgina) Dall [1870, pp. 154 and 163]	Kutorgina.
Obolella (Kutorgina) cingulata Billings [1861b, pp. 8–9, figs. 8 and 10]	Kutorgina cingulata.
Billings [1861b, p. 8, fig. 9]	Rustella edsoni.
Billings [1861c, p. 948, figs. 347 and 349]	Kutorgina cingulata.
Billings [1861c, p. 948, fig. 348]	Rustella edsoni.
Billings [1862e, p. 220, figs. 347 and 349]	Kutorgina cingulata.
Billings [1862e, p. 220, fig. 348]	Rustella edsoni.
Obolella (Linnarssonia) pretiosa Dawson [1890, pp. 53–54]	Acrotreta sagittalis.
Obolella (Orbicula) cælata Ford [1871, p. 33]	Botsfordia cælata.
Obolella (Orbicula?) crassa Ford [1871, p. 33]	Obolella crassa.
Obolellus? phillipsi Roemer [1876, Pl. II, figs. 6a–d]	Micromitra (Paterina) phillipsi.
Obolus Dall [1870, pp. 154 and 162]	Obolus.
Davidson [1853, pp. 135–136]	Obolus (in part), O. (Acritis) (in part), and O. (Mickwitzella) (in part).
Davidson [1866, p. 58]	Obolus.
Davidson [1883, p. 218]	Do.
Eichwald [1829, p. 274]	Do.
Eichwald [1860, pp. 924–925]	Obolus (in part), O. (Acritis) (in part) and O. (Mickwitzella) (in part).
Hall and Clarke [1892a, pp. 242–243]	Obolus.
Hall and Clarke [1892b, pp. 558–559]	Do.
Hall and Clarke [1892c, pp. 80–81 and 337–339]	Do.
Kutorga [1848, pp. 250–253]	Do.
Matthew [1892, pp. 43–44]	Do.
Matthew [1903, p. 135]	Do.
Mickwitz [1892, pp. 57–64]	Do.
Mickwitz [1896, pp. 1–133 (127–129)]	Do.
Morris [1849, pp. 319–320]	Do.
Oehlert [1887, p. 1261]	Do.
de Verneuil [1845, p. 291]	Do.
Walcott [1898b, pp. 385–386]	Do.
Walcott [1901, pp. 681–683]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
Zittel [1880, p. 664]	Do.
Obolus acadica Walcott [1905a, pp. 324–325]	Obolus acadicus.
Obolus? advena Barrande [1879b, Pl. XCV, fig. iv]	Obolus? advenus.
Obolus æquiputeis Matthew [1902c, p. 94]	Obolus selwyni.
Matthew [1903, p. 139]	Do.
Obolus anceps Walcott [1898b, pp. 388–389]	Obolus anceps.
Obolus antiquissimus Eichwald [1859, Pl. XXXVII, figs. 5a–d]	Obolus (Acritis) antiquissimus.
Eichwald [1860, pp. 928–929]	Do.
Obolus apollinis Billings [1872a, p. 218]	Obolus apollinis.
Billings [1872c, p. 356]	Do.
Davidson [1853, figs. 51 and 52, p. 136, and Pl. IX, figs. 280–284]	Do.
Davidson [1853, Pl. IX, fig. 285]	Obolus (Acritis) antiquissimus.
Eichwald [1829, p. 274]	Obolus apollinis.
Eichwald [1840, p. 167]	Do.
Eichwald [1843b, p. 140]	Do.
Eichwald [1860, pp. 925–926]	Do.
Gagel [1890, pp. 21–22]	Do.
Hall and Clarke [1892a, figs. 247 and 248, p. 242]	Do.
Hall and Clarke [1892b, figs. 247 and 248, p. 558]	Do.
Hall and Clarke [1892c, p. 80]	Do.
Kutorga [1848, pp. 251 and 252]	Do.
Matthew [1892, pp. 43–44]	Do.
Mickwitz [1896, pp. 133–137]	Do.
Moberg and Segerberg [1906, p. 65]	Do.
Morris [1849, p. 316]	Do.
Noetling [1883, p. 265]	Do.

	Present reference.
Obolus apollinis Roemer [1876, Pl. II, figs. 7a–c]	Obolus apollinis.
Roemer [1885, pp. 23–24 (270–271)]	Do.
Schmidt [1861, p. 218]	Do.
de Verneuil [1845, pp. 290–292]	Obolus apollinis (in part), O. apollinis ingricus (in part), O. (Acritis) antiquissimus (in part), and O. (Mickwitzella) siluricus (in part).
Walcott [1898b, Pl. XXVI, figs. 3–6]	Obolus apollinis.
Westergård [1909, p. 56]	Do.
Zittel [1880, figs. 488a–c, p. 664]	Do.
Zittel [1880, fig. 488d, p. 664]	Obolus apollinis quenstedti.
Obolus apollinis ingricus Mickwitz [1896, pp. 137–140]	Obolus apollinis ingricus.
Obolus apollinis maximus Mickwitz [1896, pp. 140–143]	Obolus apollinis maximus.
Obolus apollinis quenstedti Mickwitz [1896, pp. 143–145]	Obolus apollinis quenstedti.
Obolus appolinus? Owen [1852, p. 501]	Dicellomus politus.
Obolus? bohemicus Barrande [1879b, Pl. CII, figs. VII: 1–3]	Acrothele bohemica.
Obolus bretonensis Matthew [1902c, p. 95]	Obolus (Palæobolus) bretonensis.
Obolus celatus orbiculatus Moberg and Segerberg [1906, p. 65]	Obolus (Schmidtia) celatus.
Westergård [1909, p. 56]	Do.
Wiman [1902, p. 62]	Do.
Obolus? complexus Barrande [1879b, Pls. XCV, CXI, CXIII, and CLII]	Obolus complexus.
Obolus discus Matthew [1902c, p. 94]	Lingulella triparilis.
Obolus eichwaldi Mickwitz [1896, pp. 154–155]	Obolus eichwaldi.
Obolus elegans Mickwitz [1896, pp. 157–158]	Obolus elegans.
Obolus ella Matthew [1902c, pp. 96 and 110]	Obolus (Westonia) ella.
Obolus? inflatus Westergård [1909, p. 76]	Obolus? inflatus.
Obolus ingricus Eichwald [1829, p. 274]	Obolus apollinis ingricus.
Eichwald [1843b, p. 140–141]	Do.
Eichwald [1860, pp. 926–927]	Do.
von Leuchtenberg [1843, p. 16]	Do.
Obolus ismene Walcott [1905a, p. 325]	Obolus ismene.
Obolus labradoricus Billings [1861b, p. 6]	Micromitra (Paterina) labradorica.
Billings [1861c, p. 946]	Do.
Billings [1862e, p. 218]	Do.
Billings [1863, p. 284]	Do.
Obolus lens Matthew [1902c, p. 95]	Obolus (Palæobolus) bretonensis lens.
Obolus lens-primus Matthew [1902c, pp. 94–95]	Do.
Obolus loperi Walcott [1898c, pp. 389–390]	Obolus loperi.
Obolus mcconnelli Walcott [1908c, Pl. I, fig. 2]	Obolus mcconnelli.
Walcott [1908c, Pl. I, fig. 2a]	Obolus septalis.
Obolus mcconnelli decipiens Walcott [new]	Obolus mcconnelli decipiens.
Obolus? major Matthew [1890, p. 155]	Rustella? major.
Obolus matinalis? Walcott [1905a, p. 325]	Obolus matinalis?.
Obolus membranaceous Walcott [1908d, p. 61]	Obolus membranaceus.
Obolus (?) meneghini Walcott [1901, p. 684]	Obolus? meneghinii.
Obolus mickwitzi Walcott [1898b, pp. 386–387]	Obolus mickwitzi.
Obolus? minimus Barrande [1879b, Pl. XCV, figs. II: 1–5]	Acrotreta? minima.
Obolus minimus Walcott [1905a, pp. 325–326]	Obolus minimus.
Obolus? minor Barrande [1868a, p. 105]	Obolus? minor.
Barrande [1868b, p. 693]	Do.
Obolus? monilifer Linnarsson [1871, pp. 9–10]	Mickwitzia monilifera.
Obolus? murrayi Billings [1865b, p. 362]	Obolus? murrayi.
Obolus namouna Walcott [1898b, p. 390]	Obolus namouna.
Obolus nundina Walcott [1905a, p. 326]	Obolus nundina.
Obolus obscurus Walcott [1905a, p. 326]	Obolus obscurus.
Obolus obtusus? Moberg and Segerberg [1906, p. 65]	Obolus (Schmidtia) obtusus.
Westergård [1909, p. 57]	Do.
Wiman [1902, p. 63]	Do.
Obolus? palliatus Barrande [1868a, pp. 104–105, fig. 64]	Obolus? bavaricus.
Barrande [1868a, pp. 104–105, fig. 65]	Obolus? palliatus.
Barrande [1868b, p. 693, fig. 64]	Obolus? bavaricus.
Barrande [1868b, p. 693, fig. 65]	Obolus? palliatus.

	Present reference.
Obolus pandemia Walcott [1898b, p. 388]	Obolus pandemia.
Obolus panderi Mickwitz [1896, pp. 149–151]	Obolus panderi.
Obolus parvus Walcott [1908d, pp. 61–62]	Obolus parvus.
Obolus pectenoides Whitfield [1875, p. 103]	Dicellomus pectenoides.
Obolus? pectenoides Whitfield [1880, pp. 338–339]	Dicellomus pectenoides.
Obolus pheres Walcott [1905a, p. 328]	Obolus pheres.
Obolus pristinus Matthew [1895a, pp. 121–122]	Trematobolus pristinus.
Matthew [1902c, p. 96]	Do.
Obolus? pulcher Hall and Clarke [1892c, pp. 81 and 183]	Botsfordia pulchra.
Obolus pulcher Matthew [1889, p. 306]	Do.
Matthew [1890, pp. 151–155]	Do.
Obolus quenstedti Hall and Clarke [1892a, p. 243]	Obolus apollinis quenstedti.
Hall and Clarke [1892b, p. 559]	Do.
Hall and Clarke [1892c, p. 339]	Do.
Matthew [1903, p. 120]	Do.
Mickwitz [1892, p. 62]	Do.
Walcott [1898b, p. 385]	Do.
Obolus refulgens Matthew [1892, pp. 44–45]	Obolus refulgens.
Matthew [1902c, p. 96]	Do.
Obolus? refulgens Mickwitz [1896, pp. 23–24]	Do.
Obolus rhea Walcott [1898b, pp. 387–388]	Obolus rhea.
Obolus? rokitzanensis Barrande [1879b, Pl. CXXVI]	Obolus rokitzanensis.
Obolus salteri Brögger [1882, pp. 44–45]	Obolus (Bröggeria) salteri.
Obolus? salteri Dall [1870, p. 163]	Do.
Mickwitz [1896, p. 19]	Do.
Obolus schmidti Mickwitz [1896, pp. 152–154]	Obolus schmidti.
Obolus shensiensis Walcott [1905a, p. 327]	Obolus shansiensis.
Obolus siluricus Eichwald [1843a, pp. 7–8]	Obolus (Mickwitzella) siluricus.
Eichwald [1859, Pl. XXXVII, figs. 6 and 7a–b]	Do.
Eichwald [1860, pp. 927–928]	Do.
Mickwitz [1892, p. 60]	Do.
Schmidt [1861, p. 218]	Do.
Schmidt [1881, p. 17]	Do.
Siemiradzki [1886, p. 672]	Obolus (Acritis) antiquissimus.
Obolus smithi Walcott [1908d, pp. 62–63, Pl. VII, fig. 9a]	Obolus smithi.
Walcott [1908d, Pl. VII, fig. 9]	Micromitra (Paterina) major.
Obolus tetonensis Walcott [1901, p. 684]	Obolus tetonensis.
Walcott [1905a, p. 327]	Do.
Obolus tetonensis leda Walcott [1908d, p. 63]	Obolus tetonensis leda.
Obolus tetonensis ninus Walcott [1905a, p. 328]	Obolus tetonensis ninus.
Obolus torrentis Matthew [1902c, p. 94]	Obolus? torrentis.
Matthew [1903, p. 76]	Do.
Obolus triangularis Mickwitz [1896, pp. 145–147]	Obolus triangularis.
Moberg and Segerberg [1906, p. 65]	Do.
Westergård [1909, p. 56]	Do.
Obolus triangularis inornatus Mickwitz [1896, pp. 148–149]	Do.
Obolus triparilis Matthew [1902c, p. 94]	Lingulella triparilis.
Obolus volborthi Mickwitz [1896, pp. 155–157]	Obolus volborthi.
Obolus wortheni Walcott [1908d, pp. 63–64]	Obolus wortheni.
Obolus? zoppi Walcott [1901, pp. 684–685]	Obolus? zoppi.
Obolus sp. Kayser [1876, pp. 9–10]	Obolus? sp. undt.
Obolus? sp. Kjerulf [1873, p. 83, figs. 10 and 11]	Obolella mobergi?.
Obolus (?) sp. indet. Linnarsson [1876, p. 16]	Obolus sp. undt. g.
Obolus (Acritis) Mickwitz [1896, pp. 205–206]	Obolus (Acritis).
Walcott [1901, p. 683]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
Obolus (Acritis) antiquissimus Mickwitz [1896, pp. 206–213]	Obolus (Acritis) antiquissimus.
Obolus (Acritis) antiquissimus ventrosus Mickwitz [1896, pp. 213–214]	Do.
Obolus (Acritis?) rugatus Walcott [1901, p. 694]	Obolus (Acritis?) rugatus.
Obolus (Botsfordia) Matthew [1891, p. 148]	Botsfordia.
Matthew [1892, p. 63]	Do.
Obolus (Botsfordia) pulcher Matthew [1891, p. 148]	Botsfordia pulchra.
Matthew [1892, pp. 62–63]	Do.

	Present reference.
Obolus (Botsfordia) pulcher Matthew [1902c, p. 95]	Botsfordia pulchra.
Obolus (Botsfordia) pulchra Matthew [1894, pp. 90–91]	Do.
Matthew [1895a, pp. 115–121]	Do.
Obolus (Bröggeria) Walcott [1902, p. 605]	Obolus (Bröggeria).
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
Obolus (Bröggeria) salteri Moberg and Segerberg [1906, p. 64]	Obolus (Bröggeria) salteri.
Walcott [1902, pp. 605–606]	Do.
Obolus (Bröggeria) salteri var.? Westergård [1909, p. 56]	Do.
Obolus (Eoobolus) Matthew [1903, pp. 135–136]	Obolus (in part) and Lingulella (in part).
Obolus (Eoobolus) discus Matthew [1903, pp. 138–139]	Lingulella triparilis.
Obolus (Eoobolus) triparilis Matthew [1903, pp. 136–137]	Do.
Obolus (Euobolus) Mickwitz [1896, pp. 129 and 133]	Lingulella (in part) and Obolus (in part).
Obolus (Fordinia) Walcott [1908d, pp. 64–65]	Obolus (Fordinia).
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
Obolus (Fordinia) gilberti Walcott [1908d, p. 65]	Obolus (Fordinia) gilberti.
Obolus (Fordinia) perfectus Walcott [1908d, pp. 65–66]	Obolus (Fordinia) perfectus.
Obolus (Leptembolon) Mickwitz [1896, p. 199]	Lingulella (Leptembolon).
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
Obolus (Leptembolon) lingulæformis Mickwitz [1896, pp. 200–204]	Lingulella (Leptembolon) lingulæformis.
Obolus (Leptembolon) lingulæformis solidus Mickwitz [1896, pp. 204–205]	Do.
Obolus (Lingulella) Walcott [1898b, pp. 390–392]	Lingulella.
Walcott [1901, p. 683]	Do.
Obolus (Lingulella) acutangulus Walcott [1898b, pp. 393 and 394, Pls. XXVII and XXVIII]	Lingulella acutangula.
Obolus (Lingulella) amplus Walcott [1898b, pp. 392 and 394, Pl. XXVIII]	Lingulella ampla.
Obolus (Lingulella) argutus Walcott [1898b, p. 396]	Lingulella arguta.
Obolus (Lingulella) atavus Walcott [1902, pp. 609–610]	Lingulella atava.
Obolus (Lingulella) auga Walcott [1898b, pp. 396–397]	Lingulella auga.
Obolus (Lingulella) bellulus Matthew [1903, p. 205]	Lingulella bellula.
Walcott [1898b, p. 398]	Do.
Obolus (Lingulella) bellus Matthew [1903, p. 204]	Lingulella bella.
Walcott [1898b, pp. 397–398]	Do.
Walcott [1901, pp. 685–687]	Lingulella bella (in part), L. concinna (in part), and L. lens (in part).
Obolus (Lingulella) bicensis Walcott [1901, p. 688]	Botsfordia cælata.
Obolus (Lingulella) bornemanni Walcott [1901, pp. 687–688]	Lingulella bornemanni.
Obolus (Lingulella) canius Walcott [1902, pp. 610–611]	Lingulella cania.
Obolus (Lingulella) celatus Walcott [1898b, Pl. XXVI, figs. 1 and 2]	Obolus (Schmidtia) celatus.
Obolus (Lingulella) chinensis Walcott [1905a, pp. 328–329]	Obolus chinensis.
Obolus (Lingulella) chuarensis Walcott [1898b, p. 399]	Obolus (Westonia) chuarensis.
Obolus (Lingulella) collicia Walcott [1902, p. 610]	Lingulella collicia.
Obolus (Lingulella) concinnus Walcott [1902, pp. 608–609]	Lingulella concinna.
Obolus (Lingulella) cuneolus Walcott [1899, p. 443]	Lingulella cuneola.
Obolus (Lingulella) damesi Walcott [1905a, p. 329]	Obolus damesi. (See Lingulella damesi, p. 489.)
Obolus (Lingulella) davisii Walcott [1898b, pp. 394 and 395]	Lingulella davisi.
Obolus (Lingulella) desideratus Walcott [1898b, pp. 399–400]	Lingulella desiderata.
Walcott [1899, pp. 445–446, Pl. LX, fig. 2]	Do.
Walcott [1899, pp. 445–446, Pl. LX, fig. 2a]	Obolus rotundatus.
Obolus (Lingulella) discoideus Walcott [1901, p. 673]	Obolus discoideus.
Obolus (Lingulella) dubius Walcott [1898b, p. 401]	Lingulella dubia.
Obolus (Lingulella) ella Walcott [1898b, Pl. XXVIII, figs. 5–8]	Obolus (Westonia) ella.
Obolus (Lingulella) ellsi Walcott [1898b, p. 402]	Lingulella ellsi.
Obolus (Lingulella) euglyphus Walcott [1898b, pp. 402–403]	Obolus (Westonia) euglyphus.
Obolus (Lingulella) fragilis Walcott [1898b, p. 404]	Obolus fragilis.
Obolus (Lingulella) franklinensis Walcott [1898b, pp. 404–405]	Lingulella franklinensis.
Obolus (Lingulella) fuchsi Walcott [1905a, p. 332]	Lingulella fuchsi.
Obolus (Lingulella) gemmulus Walcott [1901, p. 673]	Lingulella ferruginea.
Obolus (Lingulella) hayesi Walcott [1898b, pp. 405–406]	Lingulella hayesi.
Obolus (Lingulella) helena Walcott [1898b, p. 406]	Lingulella helena.
Obolus (Lingulella) ino Walcott [1898b, pp. 406–407]	Lingulella ino.
Obolus (Lingulella) isse Walcott [1905a, p. 330]	Lingulella isse.
Obolus (Lingulella) lamborni minimus Walcott [1898b, p. 407]	Obolus lamborni minimus.

	Present reference.
Obolus (Lingulella) leus Walcott [1902, pp. 606–607]	Lingulella lens.
Obolus (Lingulella) leos Walcott [1898b, pp. 407–408]	Lingulella leos.
Obolus (Lingulella) lineolatus Walcott [1898b, pp. 408–409]	Lingulella lineolata.
Obolus (Lingulella) linnarssoni Walcott [1901, p. 688]	Lingulella linnarssoni.
Obolus (Lingulella) mæra Walcott [1899, p. 443]	Obolus mæra.
Obolus (Lingulella) matinalis Walcott [1899, p. 443]	Obolus matinalis.
Obolus (Lingulella) mosia osceola Walcott [1898b, p. 409]	Lingulella mosia osceola.
Obolus (Lingulella) nanno Walcott [1898b, p. 409]	Lingulella nanno.
Obolus (Lingulella) orus Walcott [1905a, p. 330]	Lingulella ora.
Obolus (Lingulella) oweni Walcott [1898b, p. 410]	Lingulella oweni.
Obolus (Lingulella) pelias Walcott [1905a, pp. 330–331]	Obolus meconnelli pelias.
Obolus (Lingulella) perattenuatus Walcott [1899, p. 443]	Lingulella perattenuata.
Obolus (Lingulella) phaon Walcott [1898b, pp. 410–411]	Lingulella phaon.
Obolus (Lingulella) pogonipensis Walcott [1898b, pp. 411–412]	Lingulella pogonipensis.
Obolus (Lingulella) prindlei Walcott [1898b, p. 412]	Obolus prindlei.
Obolus (Lingulella) punctatus Walcott [1898b, pp. 412–413]	Lingulella punctata.
Obolus (Lingulella) quadrilateralis Walcott [1905a, p. 331]	Lingulella quadrilateralis.
Obolus (Lingulella) randomensis Walcott [1901, pp. 688–689]	Lingulella randomensis.
Obolus (Lingulella) rogersi Walcott [1898b, pp. 413–415]	Obolus (Westonia) rogersi.
Obolus (Lingulella) rotundatus Walcott [1898b, p. 415]	Obolus rotundatus.
Obolus (Lingulella) schmalenseei Walcott [1902, p. 605]	Obolus schmalenseei.
Obolus (Lingulella) schucherti Walcott [1901, pp. 689–690]	Lingulella schucherti.
Obolus (Lingulella) septalis Walcott [1905a, p. 331]	Obolus septalis.
Obolus (Lingulella) siemiradzkii Walcott [1901, pp. 690–691]	Lingulella siemiradzkii.
Obolus (Lingulella) similis Walcott [1898b, pp. 415–416]	Lingulella similis.
Obolus (Lingulella) sinoe Walcott [1898b, pp. 416–417]	Obolus sinoe.
Obolus (Lingulella) spatulus Walcott [1902, p. 607]	Lingulella (Lingulepis) spatula.
Obolus (Lingulella) tarpa Walcott [1898b, pp. 417–418]	Lingulella tarpa.
Obolus (Lingulella) upis Walcott [1905a, pp. 331–332]	Lingulella upis.
Obolus (Lingulella) wanniecki Walcott [1905a, p. 332]	Lingulella wanniecki.
Obolus (Lingulella) welleri Walcott [1902, p. 608]	Lingulella welleri.
Obolus (Lingulella) willisi Walcott [1898b, pp. 418–419]	Obolus willisi.
Obolus (Lingulella) winona convexus Walcott [1901, p. 691]	Lingulella winona convexa.
Obolus (Lingulella) zetus Walcott [1898b, p. 419]	Obolus zetus.
Obolus (Lingulepis) Walcott [1899, pp. 443–444]	Lingulella (Lingulepis).
Walcott [1901, p. 683]	Do.
Obolus (Lingulepis) acuminatus Walcott [1899, p. 443]	Lingulella (Lingulepis) acuminata.
Obolus (Lingulepis) acuminatus meeki Walcott [1899, p. 444]	Lingulella (Lingulepis) acuminata meeki.
Obolus (Lingulepis) eros Walcott [1905a, p. 333]	Lingulella (Lingulepis) eros.
Obolus (Lingulepis) gregwa Walcott [1901, pp. 692–694]	Lingulella atava (in part), L. tumida (in part), L. cania (in part), L. (Lingulepis) gregwa (in part), and L. (L.) exigua (in part).
Obolus (Lingulepis) primus Walcott [1901, p. 673]	Lingulella prima.
Obolus (Lingulepis) rowei Walcott [1905a, p. 334]	Lingulella (Lingulepis) rowei.
Obolus (Lingulepis) sp. undt. Walcott [1906, pp. 567–568]	Lingulella (Lingulepis?) sp. undt.
Obolus (Lingulobolus) Walcott [1901, p. 683]	Obolus (Lingulobolus).
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
Obolus (Lingulobolus) affinis Walcott [1898a, p. 327]	Obolus (Lingulobolus) affinis.
Obolus (Lingulobolus) spissus Walcott [1898a, p. 327]	Obolus (Lingulobolus) spissus.
Obolus (Lucina) antiquissimus Eichwald [1843b, pp. 142–144]	Obolus (Acritis) antiquissimus.
Obolus (Mickwitzella) Walcott [1908d, p. 70]	Obolus (Mickwitzella).
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
Obolus (Monobolina) refulgens Matthew [1902c, p. 98]	Obolus refulgens.
Obolus (Palæobolus) Walcott [1908e, Pl. XI, and pp. 142 and 144]	Obolus (Palæobolus).
Obolus (Palæobolus) lens Matthew [1903, pp. 144–146]	Obolus (Palæobolus) bretonensis lens.
Obolus (Palæobolus) lens longus Matthew [1903, pp. 146–147]	Do.
Obolus (Schmidtia) Mickwitz [1896, p. 158]	Obolus (Schmidtia).
Walcott [1901, p. 683]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
Obolus (Schmidtia) acuminatus Mickwitz [1896, pp. 179–183]	Obolus (Schmidtia) acuminatus.
Obolus (Schmidtia) acuminatus alatus Mickwitz [1896, pp. 183–184]	Do.

	Present reference.
Obolus (Schmidtia) acuminatus humeratus Mickwitz [1896, pp. 184–186]	Obolus (Schmidtia) acuminatus.
Obolus (Schmidtia) acuminatus subtriangularis Mickwitz [1896, pp. 186–187]	Do.
Obolus (Schmidtia) celatus Mickwitz [1896, pp. 159–163]	Obolus (Schmidtia) celatus.
Obolus (Schmidtia) celatus orbiculatus Mickwitz [1896, pp. 163–165]	Do.
Obolus (Schmidtia) celatus præcisus Mickwitz [1896, pp. 166–167]	Do.
Obolus (Schmidtia) crassus Mickwitz [1896, pp. 187–193]	Obolus (Schmidtia) crassus.
Obolus (Schmidtia) crassus angulatus Mickwitz [1896, pp. 193–194]	Do.
Obolus (Schmidtia) obtusus Mickwitz [1896, pp. 167–171]	Obolus (Schmidtia) obtusus.
Obolus (Schmidtia) obtusus acutus Mickwitz [1896, pp. 172–173]	Do.
Obolus (Schmidtia) obtusus ellipticus Mickwitz [1896, pp. 177–178]	Do.
Obolus (Schmidtia) obtusus extenuatus Mickwitz [1896, pp. 178–179]	Do.
Obolus (Schmidtia) obtusus latus Mickwitz [1896, pp. 174–175]	Do.
Obolus (Schmidtia) obtusus longus Mickwitz [1896, pp. 171–172]	Do.
Obolus (Schmidtia) obtusus minutus Mickwitz [1896, pp. 175–177]	Do.
Obolus (Thysanotos) Mickwitz [1896, pp. 194–195]	Obolus (Mickwitzella).
Obolus (Thysanotos) siluricus Mickwitz [1896, pp. 195–199]	Obolus (Mickwitzella) siluricus.
Obolus (Thysanotus) Walcott [1901, p. 683]	Obolus (Mickwitzella).
Obolus (Westonia) Walcott [1901, pp. 683 and 691]	Obolus (Westonia).
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
Obolus (Westonia) alandensis Walcott [1905a, p. 334]	Obolus (Westonia) ålandensis.
Obolus (Westonia) aurora Walcott [1901, p. 691]	Obolus (Westonia) aurora.
Obolus (Westonia) baltica Walcott [1905a, p. 334]	Obolus (Westonia) balticus.
Obolus (Westonia) blackwelderi Walcott [1905a, p. 335]	Obolus (Westonia) blackwelderi.
Obolus (Westonia) bottnica Walcott [1905a, pp. 335–336]	Obolus (Westonia) bottnicus.
Obolus (Westonia) chuarensis Walcott [1901, p. 691]	Obolus (Westonia) chuarensis.
Obolus (Westonia) dartoni Walcott [1908d, p. 67]	Obolus (Westonia) dartoni.
Obolus (Westonia) ella Walcott [1901, p. 691]	Obolus (Westonia) ella.
Obolus (Westonia) ella onaquiensis Walcott [1908d, pp. 67–68]	Obolus (Westonia) ella onaquiensis.
Obolus (Westonia) elongatus Walcott [1908d, p. 68]	Obolus (Westonia) elongatus.
Obolus (Westonia) escasoni Walcott [1901, p. 691]	Obolus (Westonia) escasoni.
Obolus (Westonia) euglyphus Walcott [1901, p. 691]	Obolus (Westonia) euglyphus.
Obolus (Westonia) finlandensis Walcott [1902, pp. 611–612]	Obolus (Westonia) finlandensis.
Obolus (Westonia) iphis Walcott [1905a, p. 336]	Obolus (Westonia) iphis.
Obolus (Westonia?) lamellosus Walcott [1901, p. 691]	Obolus (Westonia?) lamellosus.
Obolus (Westonia) notchensis Walcott [1908d, p. 69]	Obolus (Westonia) notchensis.
Obolus (Westonia) rogersi Walcott [1901, p. 691]	Obolus (Westonia) rogersi.
Obolus (Westonia) stoneanus Walcott [1901, p. 691]	Obolus (Westonia) stoneanus.
Obolus (Westonia) themis Walcott [1905a, pp. 336–337]	Obolus (Westonia) themis.
Obolus (Westonia) wasatchensis Walcott [1908d, pp. 69–70]	Obolus (Westonia) wasatchensis.
Obolus (Westonia) wimani Walcott [1905a, p. 337]	Obolus (Westonia) wimani.
obscura [Billingsella], Walcott [1905a, p. 239]	Billingsella obscura.
obscurus [Obolus], Walcott [1905a, p. 326]	Obolus obscurus.
obtusus? [Obolus], Moberg and Segerberg [1906, p. 65]	Obolus (Schmidtia) obtusus.
Westergård [1909, p. 57]	Do.
Wiman [1902, p. 63]	Do.
obtusus [Obolus (Schmidtia)], Mickwitz [1896, pp. 167–171]	Do.
obtusus acutus [Obolus (Schmidtia)], Mickwitz [1896, pp. 172–173]	Do.
obtusus ellipticus [Obolus (Schmidtia)], Mickwitz [1896, pp. 177–178]	Do.
obtusus extenuatus [Obolus (Schmidtia)], Mickwitz [1896, pp. 178–179]	Do.
obtusus latus [Obolus (Schmidtia)], Mickwitz [1896, pp. 174–175]	Do.
obtusus longus [Obolus (Schmidtia)], Mickwitz [1896, pp. 171–172]	Do.
obtusus minutus [Obolus (Schmidtia)], Mickwitz [1896, pp. 175–177]	Do.
occidens [Mickwitzia], Walcott [1908d, p. 54]	Mickwitzia occidens.
œlandica [Acrotreta], Westergård [1909, p. 76]	Acrotreta œlandica.
onaquiensis [Obolus (Westonia) ella], Walcott [1908d, pp. 67–68]	Obolus (Westonia) ella onaquiensis.
ophirensis [Acrotreta], Walcott [1902, pp. 591–592]	Acrotreta ophirensis.
ophirensis [Acrotreta cf.], Walcott [new]	Acrotreta cf. ophirensis.
ophirensis [Iphidella pannula], Walcott [1905a, p. 306]	Micromitra (Iphidella) pannula ophirensis.
ophirensis descendens [Acrotreta], Walcott [1908d, p. 95]	Acrotreta ophirensis descendens.
ophirensis rugosus [Acrotreta], Walcott [1902, p. 592]	Acrotreta ophirensis rugosa.
ora [Micromitra (Paterina) stissingensis], Walcott [new]	Micromitra (Paterina) stissingensis ora.

	Present reference.
Orbicella Dall [1877, p. 50]	Keyserlingia (in part).
Dana [1846]	Does not equal Keyserlingia.
Hall and Clarke [1892a, p. 254]	Keyserlingia.
Hall and Clarke [1892b, p. 570]	Do.
d'Orbigny [1850, p. 20]	Do.
Orbicella buchi Hall and Clarke [1892a, p. 254]	Keyserlingia buchi.
d'Orbigny [1850, p. 20]	Keyserlingia buchi (in part).
Orbicula de Verneuil [1845, p. 288]	Keyserlingia.
Orbicula buchi de Verneuil [1845, pp. 288–289]	Keyserlingia buchi.
Orbicula cælata Hall [1847, p. 290]	Botsfordia cælata.
(Orbicula) cælata [Obolella], Ford [1871, p. 33]	Do.
Orbicula? crassa Hall [1847, p. 290]	Obolella crassa.
(Orbicula?) crassa [Obolella], Ford [1871, p. 33]	Do.
Orbicula prima Owen [1852, p. 583]	Obolus matinalis.
(Orbicula) primæva [Discina], de Verneuil and Barrande [1860, p. 532]	Acrothele primæva.
orbiculatus [Obolus celatus], Moberg and Segerberg [1906, p. 65]	Obolus (Schmidtia) celatus.
Westergård [1909, p. 56]	Do.
Wiman [1902, p. 62]	Do.
orbiculatus [Obolus (Schmidtia) celatus], Mickwitz [1896, pp. 163–165]	Do.
Orbiculoidea Hall and Clarke [1892c, pp. 120–137]	Orbiculoidea.
d'Orbigny	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 147]	Do.
Orbiculoidea pileolus Hall and Clarke [1892c, p. 137]	Orbiculoidea pileolus.
ordovicensis [Lingula?], Moberg and Segerberg [1906, p. 63]	Lingulella lepis.
orientalis [Billingsella], Hall and Clarke [1892c, p. 230]	Billingsella orientalis.
Walcott [1905a, pp. 239–240]	Do.
orientalis [Iphidella labradorica], Walcott [1905a, pp. 305–306]	Micromitra (Paterina) labradorica orientalis.
orientalis [Orthisina], Walcott [1886b, p. 120]	Billingsella orientalis.
Walcott [1891a, p. 613]	Do.
Whitfield [1884, p. 144]	Do.
orientalis [Syntrophia], Walcott [1905a, p. 292]	Huenella orientalis.
orientalis [Yorkia?], Walcott [1906, pp. 569–570]	Yorkia? orientalis.
ornatella [Iphidea], Grönwall [1902, p. 40]	Micromitra (Iphidella) ornatella.
Hall and Clarke [1892c, pp. 97–98]	Do.
Linnarsson [1876, pp. 25–26]	Do.
ornatella [Iphidea cnf.?], Hall and Clarke [1892c, Pl. IV, figs. 6 and 7]	Micromitra (Paterina) superba.
orta [Acrothyra signata], Matthew [1902b, pp. 385–386]	Acrothyra signata orta.
Matthew [1903, pp. 89–90]	Do.
orthia [Syntrophia], Walcott [1905b, pp. 11–12]	Syntrophia orthia.
Orthis von Buch (in part) [1841, p. 7]	Obolus.
Orthis barabuensis A. Winchell [1864, p. 228]	Syntrophia barabuensis.
Orthis bavarica Barrande [1868a, p. 99]	Eoorthis bavarica.
Barrande [1868b, p. 690]	Do.
Orthis billingsi Hartt [1868, pp. 644–645]	Protorthis billingsi.
Hartt [1878, pp. 644–645]	Do.
Hartt [1891, pp. 644–645]	Do.
Matthew [1886, p. 43]	Do.
Walcott [1884a, pp. 17–18]	Do.
Orthis christianiæ Brögger [1882, p. 48]	Eoorthis christianiæ (in part) and E. daunus (in part).
Gagel [1890, pp. 10 and 34]	Eoorthis daunus.
Kjerulf [1865, pp. 1 and 3]	Eoorthis christianiæ.
Pompeckj [1902, p. 7]	Eoorthis daunus.
Remelé [1881, p. 69]	Do.
Remelé [1885, p. 6]	Do.
Roemer [1885, pp. 36, 37, and 38]	Do.
Orthis coloradoensis Meek [1870, p. 425]	Eoorthis desmopleura.
Shumard [1860, p. 627]	Billingsella coloradoensis.
Orthis desmopleura Meek [1872, p. 295]	Eoorthis desmopleura.
Orthis? eurekensis Schuchert [1897, p. 286]	Orusia? eurekensis.
Orthis eurekensis Walcott [1884b, pp. 22–23]	Do.
Orthis exporecta Linnarsson [1876, pp. 12–13]	Billingsella exporrecta.

	Present reference.
Orthis exporrecta Kayser [1883, p. 35]	Billingsella exporrecta.
Wallerius [1895, p. 66]	Do.
Orthis hamburgensis Walcott [1884b, p. 73]	Eoorthis desmopleura?.
Orthis hicksi Kayser [1883, p. 35]	Billingsella hicksi.
Linnarsson [1876, pp. 13–14]	Billingsella exporrecta rugosicostata.
Orthis hicksii Davidson [1868, p. 314]	Billingsella hicksi.
Davidson [1869, p. 230]	Do.
Orthis? highlandensis Walcott [1886b, pp. 119–120]	Billingsella highlandensis.
Walcott [1891a, p. 612]	Do.
Orthis kuthani Pompeckj [1896b, pp. 514–515]	Nisusia (Jamesella) kuthani.
Orthis lenticularis Brögger [1882, p. 48]	Orusia lenticularis.
Davidson [1868, p. 314]	Do.
Davidson [1869, pp. 230–232]	Do.
Matthew [1892, pp. 46–48]	Do.
Matthew [1903, pp. 213–216]	Do.
Roemer [1876, Pl. II, figs. 4a–c]	Do.
Roemer [1885, pp. 33–34]	Do.
Salter [1866b, p. 339]	Do.
Salter and Etheridge [1881, pp. 544–545]	Do.
Orthis lenticularis ? Kayser [1876, p. 9]	Do.
Orthis lenticularis atrypoides Matthew [1892, p. 48]	Orusia lenticularis atrypoides.
Matthew [1903, p. 217]	Do.
Orthis lenticularis lyncioides Matthew [1892, p. 49]	Orusia lenticularis lyncioides.
Matthew [1903, p. 216]	Do.
Orthis lenticularis strophomenoides Matthew [1892, p. 49]	Orusia lenticularis.
Matthew [1903, p. 217]	Do.
Orthis lindströmi Linnarsson [1876, pp. 10–12]	Billingsella lindströmi.
Orthis linnarssoni Kayser [1883, p. 34]	Eoorthis linnarssoni.
Orthis newtonensis Weller [1903, pp. 113–114]	Eoorthis newtonensis.
Orthis (?) peculiaris Tate [1892, pp. 185–186]	Kutorgina peculiaris.
Orthis pepina Hall [1863, pp. 134–135]	Billingsella coloradoensis.
Hall [1867, p. 113]	Do.
Whitfield [1882, pp. 170–171]	Do.
Orthis perpasta Pompeckj [1896b, pp. 515–516]	Nisusia (Jamesella) perpasta.
Orthis perpasta macra Pompeckj [1896b, p. 516]	Nisusia (Jamesella) perpasta macra.
Orthis perpasta subquadrata Pompeckj [1896b, p. 516]	Nisusia (Jamesella) perpasta subquadrata.
Orthis primordialis Mallada [1875, p. 31]	Eoorthis primordialis.
de Verneuil and Barrande [1860, pp. 532–533]	Do.
Orthis quacoensis Matthew [1886, pp. 43–44]	Protorthis quacoensis.
Orthis? remnicha Walcott [1899, pp. 451–452, Pl. LXI, figs. 3 and 3a; Pl. LXII, figs. 1, 1c–d]	Eoorthis remnicha. The text includes both E. remnicha and E. iddingsi.
Orthis remnicha Walcott [1899, pp. 451–452, Pl. LXII, figs. 1a–b]	Eoorthis iddingsi. The text includes both E. iddingsi and E. remnicha.
N. H. Winchell [1886, pp. 317–318]	Eoorthis remnicha.
Orthis romingeri Barrande [1848, p. 203]	Billingsella romingeri.
Barrande [1879a, Pl. LXII, figs. II: 1–4]	Do.
Feistmantel	Nisusia (Jamesella) kuthani.
Jahn	Do.
Katzer	Do.
Krejci	Do.
Kusta	Do.
Novak	Do.
Pompeckj [1896b, pp. 513–514]	Billingsella romingeri.
Wentzel	Nisusia (Jamesella) kuthani.
Orthis salemensis Oehlert [1889, p. 1139]	Billingsella salemensis.
Walcott [1887, pp. 190–191]	Do.
Walcott [1891a, pp. 612–613]	Do.
Orthis saltensis Kayser [1876, p. 8]	Eoorthis saltensis.
Kayser [1897, p. 280]	Do.
Orthis (?) sandbergi Walcott [1899, pp. 452–453]	Otusia sandbergi.
Orthis sandbergi N. H. Winchell [1886, p. 318]	Do.

	Present reference.
Orthis (?) tatei Etheridge, jr. [1905, p. 249]	Eoorthis tatei.
Orthis ungula von Buch [1841, pp. 7–8]	Obolus apollinis.
Orthis warthi Waagen [1891, pp. 102–104]	Wynnia warthi.
Orthis sp. Kayser [1876, p. 9]	Orusia lenticularis.
Pompeckj [1896a, p. 4]	Eoorthis bavarica.
Pompeckj [1896b, p. 514, Pl. XV, fig. 6]	Eoorthis sp. undt. a.
Pompeckj [1896b, p. 514, Pl. XV, fig. 7]	Eoorthis sp. undt. b.
Orthis (or Orthisina) sp. Etheridge [1905, p. 250]	Huenella etheridgei.
Orthis (Billingsella) pepina Sardeson [1896, p. 96]	Billingsella coloradoensis.
Orthis (Finkelnburgia) Walcott [1905a, pp. 277–278]	Finkelnburgia.
Orthis (Finkelnburgia) finkelnburgi Walcott [1905a, pp. 278–279]	Finkelnburgia finkelnburgi.
Orthis (Finkelnburgia) osceola Walcott [1905a, p. 279]	Finkelnburgia osceola.
Orthis (Finkelnburgia) osceola corrugata Walcott [1905a, p. 280]	Finkelnburgia osceola corrugata.
Orthis? (Orthisina?) pepina Hall [1883, Pl. XXXVII, figs. 16–19]	Billingsella coloradoensis.
Orthis (Orusia) Walcott [1905a, p. 273]	Orusia.
Orthis (Orusia?) eurekensis Walcott [1905a, p. 277]	Orusia? eurekensis.
Orthis (Orusia) lenticularis Walcott [1905a, pp. 273–276]	Orusia lenticularis.
Orthis (Orusia) lenticularis atrypoides Walcott [1905a, p. 276]	Orusia lenticularis atrypoides.
Orthis (Orusia) lenticularis lyncioides Walcott [1905a, p. 277]	Orusia lenticularis lyncioides.
Orthis (Plectorthis) Walcott [1905a, pp. 257–259]	Eoorthis.
Orthis (Plectorthis) agreste Walcott [1906, p. 570]	Eoorthis agreste.
Orthis (Plectorthis?) atava Walcott [1905a, pp. 259–260]	Eoorthis atava.
Orthis (Plectorthis) christianiæ Moberg and Segerberg [1906, p. 69]	Eoorthis christianiæ (in part only). The reference includes also E. daunus and E. tullbergi.
Walcott [1905a, pp. 260–261]	Eoorthis christianiæ.
Orthis (Plectorthis) daunus Moberg and Segerberg [1906, p. 69]	Eoorthis daunus.
Walcott [1905a, p. 261]	Do.
Orthis (Plectorthis) desmopleura Walcott [1905a, p. 261]	Eoorthis desmopleura.
Orthis (Plectorthis) desmopleura nympha Walcott [1905a, p. 262]	Eoorthis desmopleura nympha.
Orthis (Plectorthis) diablo Walcott [1905a, p. 262]	Eoorthis? diablo.
Orthis (Plectorthis) doris Walcott [1905a, pp. 262–263]	Eoorthis doris.
Orthis (Plectorthis) hastingsensis Walcott [1905a, p. 263]	Eoorthis hastingsensis.
Orthis (Plectorthis) iddingsi Walcott [1905a, p. 264]	Eoorthis iddingsi.
Orthis (Plectorthis) indianola Walcott [1905a, pp. 264–265]	Eoorthis indianola.
Orthis (Plectorthis) johannensis Walcott [1905a, pp. 265–266]	Eoorthis johannensis.
Orthis (Plectorthis) kayseri Walcott [1905a, p. 266]	Eoorthis kayseri.
Orthis (Plectorthis) kichouensis Walcott [1906, p. 570]	Eoorthis kichouensis.
Orthis (Plectorthis) linnarssoni Walcott [1905a, p. 266]	Eoorthis linnarssoni.
Orthis (Plectorthis) newtonensis Walcott [1905a, p. 267]	Eoorthis newtonensis.
Orthis (Plectorthis) pagoda Walcott [1905a, pp. 267–268]	Eoorthis pagoda.
Orthis (Plectorthis) papias Walcott [1905a, p. 268]	Eoorthis papias.
Orthis (Plectorthis) remnicha Walcott [1905a, pp. 268–269]	Eoorthis remnicha.
Orthis (Plectorthis) remnicha sulcata Walcott [1905a, p. 269]	Eoorthis remnicha sulcata.
Orthis (Plectorthis) remnicha texana Walcott [1905a, p. 270]	Eoorthis remnicha texana.
Orthis (Plectorthis) remnicha winfieldensis Walcott [1905a, p. 270]	Eoorthis remnicha winfieldensis.
Orthis (Plectorthis) retroflexa Walcott [1905a, pp. 270–271]	Billingsella retroflexa.
Orthis (Plectorthis) saltensis Walcott [1905a, p. 271]	Eoorthis saltensis.
Orthis (Plectorthis) tullbergi Moberg and Segerberg [1906, p. 69]	Eoorthis tullbergi.
Walcott [1905a, p. 271]	Do.
Orthis (Plectorthis) wichitaensis Walcott [1905a, pp. 271–272]	Eoorthis wichitaensis.
Orthis (Plectorthis) wichitaensis læviusculus Walcott [1905a, p. 272]	Eoorthis wichitaensis læviusculus.
Orthis (Plectorthis) wimani Moberg and Segerberg [1906, p. 70]	Eoorthis wimani.
Walcott [1905a, p. 272]	Do.
Orthis (Plectorthis) sp. Walcott [1905a, pp. 272–273]	Eoorthis sp. undt. a and b.
Orthis (Plectorthis) sp. undt. Walcott [1906, p. 571]	Eoorthis various sp. undt.
Orthis (Protorthis) billingsi Wysogórski [1900, p. 227]	Protorthis billingsi.
Orthisina alherta Matthew [1902c, p. 109]	Nisusia alberta.
Walcott [1889c, p. 442]	Do.
Orthisina? billingsi Matthew [1891, p. 131]	Protorthis billingsi.
Orthisina compta Tate [1892, p. 185]	Nisusia compta.

	Present reference.
Orthisina festinata Billings [1861b, p. 10]	Nisusia festinata.
Billings [1861c, p. 949]	Do.
Billings [1862b, p. 105]	Do.
Billings [1862e, p. 221]	Do.
Billings [1863, p. 284, figs. 289a–c]	Do.
Walcott [1886b, pp. 120–121]	Do.
Walcott [1891a, p. 613]	Do.
Orthisina (?) johannensis Matthew [1892, pp. 49–50]	Eoorthis johannensis.
Orthisina orientalis Walcott [1886b, p. 120]	Billingsella orientalis.
Walcott [1891a, p. 613]	Do.
Whitfield [1884, p. 144]	Do.
Orthisina pellico de Verneuil and Barrande [1860, pp. 535–536]	Nisusia (Jamesella) pellico.
(Orthisina?) pepina [Orthis?], Hall [1883, Pl. XXXVII, figs. 16–19]	Billingsella coloradoensis.
Orthisina quacoensis Matthew [1891, p. 131]	Protorthis quacoensis.
Orthisina? transversa Walcott [1886b, p. 121]	Nisusia festinata transversa.
Walcott [1891a, p. 613]	Do.
Orthisina vaticina Mallada [1875, p. 32]	Nisusia? vaticina.
de Verneuil and Barrande [1860, pp. 533–535]	Do.
Orthisina [Orthis or] sp. Etheridge [1905, p. 250]	Huenella etheridgei.
orus [Obolus (Lingulella)], Walcott [1905a, p. 330]	Lingulella ora.
Orusia Walcott [1908e, Pl. XI, and pp. 142 and 148]	Orusia.
(Orusia) [Orthis], Walcott [1905a, p. 273]	Do.
(Orusia?) eurekensis [Orthis], Walcott [1905a, p. 277]	Orusia? eurekensis.
(Orusia) lenticularis [Orthis], Walcott [1905a, pp. 273–276]	Orusia lenticularis.
(Orusia) lenticularis atrypoides [Orthis], Walcott [1905a, p. 276]	Orusia lenticularis atrypoides.
(Orusia) lenticularis lyncioides [Orthis], Walcott [1905a, p. 277]	Orusia lenticularis lyncioides.
osceola [Obolus (Lingulella) mosia], Walcott [1898b, p. 409]	Lingulella mosia osceola.
osceola [Orthis (Finkelnburgia)], Walcott [1905a, p. 279]	Finkelnburgia osceola.
osceola corrugata [Orthis (Finkelnburgia)], Walcott [1905a, p. 280]	Finkelnburgia osceola corrugata.
Otusia Walcott [1908e, Pl. XI, and pp. 142 and 148]	Otusia.
(Otusia) [Billingsella], Walcott [1905a, p. 246]	Do.
(Otusia) sandbergi [Billingsella], Walcott [1905a, pp. 246–247]	Otusia sandbergi.
Otusia utahensis Walcott [new]	Otusia utahensis.
ovalis [Acrotreta], Walcott [1902, p. 592]	Acrotreta ovalis.
ovalis [Lingulella ferruginea], Davidson [1868, p. 307]	Lingulella ferruginea.
Hicks [Salter and Hicks, 1867, p. 341]	Do.
ovalis [Lingulella? inflata], Matthew [1895a, p. 127]	Acrotreta inflata.
ovata [Lingula], Emmons [1842, p. 105]	Lingulella prima.
McCoy [1846, p. 24]	Lingula ovata, not Lingulella davisi.
McCoy [1854, p. 254]	Lingulella davisi (in part) and Lingula ovata (in part).
oweni [Obolus (Lingulella)], Walcott [1898b, p. 410]	Lingulella oweni.
ovata [Ungula], Pander [1830, p. 59, Pl. XXVIII, figs. 6a–b]	Obolus (Schmidtia) celatus.
Pander [1830, pp. 59 and 154, Pl. III, fig. 23]	Obolus apollinis.

P.

pacifica [Acrotreta], Walcott [1905a, p. 301]	Acrotreta pacifica.
pagoda [Orthis (Plectorthis)], Walcott [1905a, pp. 267–268]	Eoorthis pagoda.
Palæobolus Matthew [1899b, pp. 201–202]	Obolus (Palæobolus).
Matthew [1903, pp. 140–141]	Do.
(Palæobolus) [Obolus], Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
Palæobolus bretonensis Matthew [1899b, p. 202]	Obolus (Palæobolus) bretonensis.
Matthew [1903, pp. 141–143]	Do.
(Palæobolus) lens [Obolus], Matthew [1903, pp. 144–146]	Obolus (Palæobolus) bretonensis lens.
(Palæobolus) lens longus [Obolus], Matthew [1903, pp. 146–147]	Do.
palliatus [Obolus?], Barrande [1868a, pp. 104–105, fig. 64]	Obolus? bavaricus.
Barrande [1868a, pp. 104–105, fig. 65]	Obolus? palliatus.
Barrande [1868b, p. 693, fig. 64]	Obolus? bavaricus.
Barrande [1868b, p. 693, fig. 65]	Obolus? palliatus.
pandemia [Obolus], Walcott [1898b, p. 388]	Obolus pandemia.
panderi [Acrothele], Walcott [new]	Acrothele panderi.

	Present reference.
panderi [Keyserlingia], Karpinsky [1887, p. 476]	Helmersenia ladogensis.
panderi [Obolus], Mickwitz [1896, pp. 149–151]	Obolus panderi.
pannula [Iphidea], Matthew [1902c, p. 110]	Micromitra (Iphidella) pannula.
pannula [Iphidella], Walcott [1905a, p. 307]	Do.
pannula [Kutorgina], Pack [1906, p. 296]	Do.
Walcott [1886b, p. 105]	Do.
Walcott [1887, p. 190]	Do.
Walcott [1891a, p. 609]	Do.
pannula [Micromitra (Iphidella)], Walcott [1908c, p. 244, Pl. 1, figs. 1, 1a–c].	Do.
pannula maladensis [Iphidella], Walcott [1905a, p. 306]	Micromitra (Iphidella) pannula maladensis.
pannula ophirensis [Iphidella], Walcott [1905a, p. 306]	Micromitra (Iphidella) pannula ophirensis.
pannulus [Iphidea], Grabau and Shimer [1907, p. 201]	Micromitra (Iphidella) pannula.
Schuchert [1897, p. 234]	Do.
pannulus [Trematis], White [1874, p. 6]	Do.
White [1877, pp. 36–37]	Do.
papellata-prima [Acrotreta], Matthew [1902a, pp. 391–392]	Acrothyra sera.
papias [Orthis (Plectorthis)], Walcott [1905a, p. 268]	Eoorthis papias.
papillata [Acrotreta], Matthew [1902b, pp. 390–391]	Acrothyra sera.
Matthew [1903, p. 95]	Do.
papillata lata [Acrotreta], Matthew [1903, pp. 95–96]	Do.
papillata-prima [Acrotreta], Matthew [1903, pp. 73–74]	Do.
papillata var. [Acrotreta], Matthew [1902b, p. 391]	Do.
parvula [Acrotreta], Walcott [1902, p. 592]	Acrotreta parvula.
parvula [Obolella], Wallerius [1895, pp. 65–66]	Do.
parvus [Dicellomus], Walcott [1905a, pp. 315–316]	Dicellomus parvus.
parvus [Obolus], Walcott [1908d, pp. 61–62]	Obolus parvus.
Paterina Beecher [1891, p. 345]	Micromitra (Paterina).
Hall and Clarke [1892a, p. 247]	Do.
Hall and Clarke [1892b, p. 563]	Do.
Walcott [1897b, p. 708]	Do.
(Paterina) [Micromitra], Walcott [1908e, Pl. XI, and pp. 142 and 143]	Micromitra (Paterina).
Paterina labradorica Beecher [1891, pp. 345–346]	Micromitra (Paterina) labradorica swantonensis.
Hall and Clarke [1892a, p. 247]	Do.
(Paterina) labradorica var. undt. [Micromitra], Walcott [new]	Micromitra (Paterina) labradorica var.undt.
(Paterina) stissingensis ora [Micromitra], Walcott [new]	Micromitra (Paterina) stissingensis ora.
(Paterina) stuarti [Micromitra], Walcott [1908d, p. 58]	Micromitra (Paterina) stuarti.
(Paterina) wapta [Micromitra], Walcott [1908d, p. 59]	Micromitra (Paterina) wapta.
(Paterina) williardi [Micromitra], Walcott [1908d, p. 60]	Micromitra (Paterina) williardi.
Paterina (Micromitra) Schuchert [1905, p. 329]	Micromitra.
pealei [Iphidea], Walcott [1897b, pp. 712–713]	Micromitra pealei.
pectenoides [Dicellomus], Walcott [1901, p. 673]	Dicellomus pectenoides.
Walcott [1905a, p. 316]	Do.
pectenoides [Obolella], Schuchert [1897, p. 275]	Do.
pectenoides [Obolus], Whitfield [1875, p. 103]	Do.
pectenoides [Obolus?], Whitfield [1880, pp. 338–339]	Do.
peculiaris [Orthis (?)], Tate [1892, pp. 185–186]	Kutorgina peculiaris.
pelias [Obolus (Lingulella)], Walcott [1905a, pp. 330–331]	Obolus mcconnelli pelias.
pellico [Orthisina], de Verneuil and Barrande [1860, pp. 535–536]	Nisusia (Jamesella) pellico.
pepina [Billingsella], Hall and Clarke [1892a, Pl. VIII, figs. 1 and 2]	Billingsella coloradoensis.
Hall and Clarke [1892c, p. 230]	Do.
pepina [Orthis], Hall [1863, pp. 134–135]	Do.
Hall [1867, p. 113]	Do.
Whitfield [1882, pp. 170–171]	Do.
pepina [Orthis (Billingsella)], Sardeson [1896, p. 96]	Do.
pepina [Orthis? (Orthisina?)], Hall [1883, Pl. XXXVII, figs. 16–19]	Do.
perattenuatus [Lingulepis], Whitfield [1877, p. 9]	Lingulella perattenuata.
Whitfield [1880, p. 337]	Do.
perattenuatus [Obolus (Lingulella)], Walcott [1899, p. 443]	Do.
perfectus [Obolus (Fordinia)], Walcott [1908d, pp. 65–66]	Obolus (Fordinia) perfectus.
perpasta [Nisusia (Jamesella)], Walcott [1905a, pp. 254–255]	Nisusia (Jamesella) perpasta.
perpasta [Orthis], Pompeckj [1896b, pp. 515–516]	Do.
perpasta macra [Nisusia (Jamesella)], Walcott [1905a, p. 255]	Nisusia (Jamesella) perpasta macra.
perpasta macra [Orthis], Pompeckj [1896b, p. 516]	Do.

	Present reference.
perpasta subquadrata [Nisusia (Jamesella)], Walcott [1905a, p. 255]	Nisusia (Jamesella) perpasta subquadrata.
perpasta subquadrata [Orthis], Pompeckj [1896b, p. 516]	Do.
perugata [Kutorgina], Walcott [1905a, p. 310]	Kutorgina perugata.
petalon [Lingula], Bornemann [1891, p. 438]	Obolus? meneghinii.
Davidson [1868, p. 308]	Does not equal Obolus? meneghinii.
Davidson [1871, p. 337]	Do.
phaon [Obolus (Lingulella)], Walcott [1898b, pp. 410–411]	Lingulella phaon.
pheres [Obolus], Walcott [1905a, p. 328]	Obolus pheres.
Philhedra von Huene [1899a, pp. 146–147]	Philhedra.
von Huene [1899b, pp. 216–218 and 297–298]	Do.
Koken [1889, pp. 465 and 467]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 147]	Do.
Philhedra? columbiana von Huene [1899b, pp. 216 and 298]	Philhedra columbiana.
Philhedra columbiana Walcott [1908c, Pl. I, figs. 5 and 5a]	Do.
phillipsi [Kutorgina cingulata], Matley [1902, pp. 145–147]	Micromitra (Paterina) phillipsi.
phillipsi [Obolella?], Davidson [1866, pp. 62–63]	Do.
phillipsi [Obolella], Holl [1865, p. 102]	Do.
Phillips [1871, p. 68]	Do.
phillipsi [Obolellus?], Roemer [1876, Pl. XI, figs. 6a–d]	Do.
phillipsia [Obolella], Dall [1877, p. 41]	Do.
pileolus [Discina], Davidson [1868, pp. 312–313]	Orbiculoidea pileolus.
Davidson [1871, p. 344]	Do.
(Hicks MS.) Salter [1866a, p. 285]	Do.
pileolus? [Discina], Hicks [1871, Pl. XV, figs. 12 and 12a]	Stenotheca pileolus, a gastropod.
pileolus [Orbiculoidea], Hall and Clarke [1892c, p. 137]	Orbiculoidea pileolus.
pinnaformis [Lingula], Owen [1852, p. 583]	Lingulella (Lingulepis) acuminata.
pinnaformis [Lingulepis], Hall [1863, pp. 129–130, Pl. VI, figs. 12 and 13]	Obolus matinalis.
Hall [1863, pp. 129–130, Pl. VI, figs. 14–16]	Lingulella (Lingulepis) acuminata.
Hall [1867, p. 107, Pl. I, figs. 12 and 13]	Obolus matinalis.
Hall [1867, p. 107, Pl. I, figs. 14–16]	Lingulella (Lingulepis) acuminata.
Whitfield [1880, p. 335]	Do.
Whitfield [1882, pp. 169–170]	Do.
pinnæformis [Lingula], Hall [1862, p. 435, and fig. 3, p. 21]	Do.
pinniformis [Lingulepis], Dwight [1886, p. 208]	Do.
Grabau and Shimer [1907, p. 193]	Do.
Hall and Clarke [1892a, p. 232]	Do.
Hall and Clarke [1892b, p. 548]	Do.
Hall and Clarke [1892c, p. 60]	Do.
Meek and Hayden [1865, pp. 2–3]	Do.
Schuchert [1897, p. 260]	Do.
plana [Ungula], Pander [1830, pp. 59 and 163]	Obolus apollinis.
plana or convexa [Ungula], Pander [1830, p. 163]	Do.
plana retroflexa [Clitambonites (Gonambonites)], Matthew [1895b, p. 267]	Billingsella retroflexa.
planus retroflexus [Clitambonites], Schuchert [1897, p. 184]	Do.
Platyceras etheridgei Tate [1892, p. 184]	Micromitra (Paterina) etheridgei.
Plectorthis Grabau and Shimer [1907, pp. 250 and 251]	Eoorthis (in part) and Plectorthis (in part).
Hall and Clarke [1892c, pp. 194–195]	Plectorthis, not Eoorthis.
(Plectorthis) [Orthis], Walcott [1905a, pp. 257–259]	Eoorthis.
(Plectorthis) agreste [Orthis], Walcott [1906, p. 570]	Eoorthis agreste.
(Plectorthis?) atava [Orthis], Walcott [1905a, pp. 259–260]	Eoorthis atava.
(Plectorthis) christianiæ [Orthis], Moberg and Segerberg [1906, p. 69]	Eoorthis christianiæ (in part only). The reference includes also E. daunus and E. tullbergi.
Walcott [1905a, pp. 260–261]	Eoorthis christianiæ.
(Plectorthis) daunus [Orthis], Moberg and Segerberg [1906, p. 69]	Eoorthis daunus.
Walcott [1905a, p. 261]	Do.
(Plectorthis) desmopleura [Orthis], Walcott [1905a, p. 261]	Eoorthis desmopleura.
(Plectorthis) desmopleura nympha [Orthis], Walcott [1905a, p. 262]	Eoorthis desmopleura nympha.
(Plectorthis) diablo [Orthis], Walcott [1905a, p. 262]	Eoorthis? diablo.
(Plectorthis) doris [Orthis], Walcott [1905a, pp. 262–263]	Eoorthis doris.
(Plectorthis) hastingsensis [Orthis], Walcott [1905a, p. 263]	Eoorthis hastingsensis.
(Plectorthis) iddingsi [Orthis], Walcott [1905a, p. 264]	Eoorthis iddingsi.

	Present reference.
Plectorthis indianola Grabau and Shimer [1907, pp. 251–252]	Eoorthis indianola.
(Plectorthis) indianola [Orthis], Walcott [1905a, pp. 264–265]	Do.
(Plectorthis) johannensis [Orthis], Walcott [1905a, pp. 265–266]	Eoorthis johannensis.
(Plectorthis) kayseri [Orthis], Walcott [1905a, p. 266]	Eoorthis kayseri.
(Plectorthis) kichouensis [Orthis], Walcott [1906, p. 570]	Eoorthis kichouensis.
(Plectorthis) linnarssoni [Orthis], Walcott [1905a, p. 266]	Eoorthis linnarssoni.
(Plectorthis) newtonensis [Orthis], Walcott [1905a, p. 267]	Eoorthis newtonensis.
(Plectorthis) pagoda [Orthis], Walcott [1905a, pp. 267–268]	Eoorthis pagoda.
(Plectorthis) papias [Orthis], Walcott [1905a, p. 268]	Eoorthis papias.
Plectorthis remnicha Grabau and Shimer [1907, p. 252]	Eoorthis remnicha.
(Plectorthis) remnicha [Orthis], Walcott [1905a, pp. 268–269]	Do.
(Plectorthis) remnicha sulcata [Orthis], Walcott [1905a, p. 269]	Eoorthis remnicha sulcata.
(Plectorthis) remnicha texana [Orthis], Walcott [1905a, p. 270]	Eoorthis remnicha texana.
(Plectorthis) remnicha winfieldensis [Orthis], Walcott [1905a, p. 270]	Eoorthis remnicha winfieldensis.
(Plectorthis) retroflexa [Orthis], Walcott [1905a, pp. 270–271]	Billingsella retroflexa.
(Plectorthis) saltensis [Orthis], Walcott [1905a, p. 271]	Eoorthis saltensis.
(Plectorthis) tullbergi [Orthis], Moberg and Segerberg [1906, p. 69]	Eoorthis tullbergi.
Walcott [1905a. p. 271]	Do.
(Plectorthis) wichitaensis [Orthis], Walcott [1905a, pp. 271–272]	Eoorthis wichitaensis.
(Plectorthis) wichitaensis læviusculus [Orthis], Walcott [1905a, p. 272]	Eoorthis wichitaensis læviusculus.
(Plectorthis) wimani [Orthis], Moberg and Segerberg [1906, p. 70]	Eoorthis wimani.
Walcott [1905a, p. 272]	Do.
(Plectorthis) sp. [Orthis], Walcott [1905a, pp. 272–273]	Eoorthis sp. undt. a and b.
(Plectorthis) sp. undt. [Orthis], Walcott [1906, p. 571]	Eoorthis various sp. undt.
plicatella [Billingsella], Walcott [1905a, pp. 240–241]	Billingsella plicatella.
pogonipensis [Obolus (Lingulella)], Walcott [1898b, pp. 411–412]	Lingulella pogonipensis.
polita [Aulonotreta], Kutorga [1848, pp. 279–282]	Obolus apollinis (in part), O. apollinis ingricus (in part), and O. (Mickwitzella) siluricus (in part).
polita [Dicellomus], Hall [1873, p. 246]	Dicellomus politus.
polita [Lingula], Hall [1861, p. 24]	Do.
polita [Lingula?], Hall [1862, pp. 21 and 435]	Do.
polita [Lingula], Whitfield [1862, p. 136]	Do.
polita [Obolella], Billings [1862c, p. 421]	Do.
polita [Obolella?], Hall [1863, pp. 133–134]	Do.
Hall [1867, pp. 112–113]	Do.
polita [Obolella], Hall and Clarke [1892c, pp. 72 and 73]	Do.
Walcott [1886b, p. 111]	Do.
Whitfield [1880, pp. 339–340]	Do.
politus [Dicellomus], Grabau and Shimer [1907, pp. 189–190]	Do.
Walcott [1899, pp. 443 and 446]	Do.
Walcott [1905a, pp. 313 and 316–318]	Do.
Polytœchia? montanensis Walcott [1905a, pp. 295–296]	Clarkella? montanensis.
præcisus [Obolus (Schmidtia) celatus], Mickwitz [1896, pp. 166–167]	Obolus (Schmidtia) celatus.
pretiosa [Acrothele], Walcott [1898b, p. 402]	Acrothele pretiosa.
pretiosa [Billingsia], Ford [1886a, p. 467]	Do.
pretiosa [Elkania], Ford [1886b, p. 325]	Do.
pretiosa [Linnarssonia], Grabau and Shimer [1907, p. 200]	Either Acrotreta sagittalis or Acrothele pretiosa. (See p. 652.)
Hall and Clarke [1892c, p. 70]	Acrotreta sagittalis.
Schuchert [1897, p. 262]	Acrotreta sagittalis (in part) and Acrothele pretiosa (in part).
Walcott [1901, p. 673]	Acrothele pretiosa.
pretiosa [Linnarssonia cf.], Hall [1890, p. 55]	Acrotreta sagittalis.
pretiosa [Mickwitzia], Walcott [1908d, pp. 54–55]	Mickwitzia pretiosa.
pretiosa [Obolella], Billings [1862d, pp. 68–69]	Acrothele pretiosa.
Billings [1863, p. 230]	Do.
Chapman [1863, p. 191]	Do.
Chapman [1864, p. 163]	Do.
pretiosa [Obolella?], Walcott [1886b, p. 111]	Do.
pretiosa [Obolella (Linnarssonia)], Dawson [1890, pp. 53–54]	Acrotreta sagittalis.
prima [Acrothele matthewi], Hall and Clarke [1892a, Pl. III, fig. 27]	Acrothele prima.
Hall and Clarke [1892c, Pl. III, fig. 25]	Do.

	Present reference.
prima [Acrothele matthewi], Matthew [1886, p. 41]	Acrothele prima.
Matthew [1895a, Pl. V, figs. 7a–b]	Do.
Matthew [1902b, pp. 397 and 402]	Do.
Matthew [1903, p. 104]	Do.
prima [Acrothyra proavia], Matthew [1901b, p. 303]	Acrothyra proavia.
Matthew [1902b, p. 389]	Do.
Matthew [1903, pp. 58, 86, and 93]	Do.
prima [Acrothyra signata], Matthew [1902b, pp. 382–383]	Acrothyra signata prima.
Matthew [1903, p. 73]	Do.
prima [Acrotreta papillata], Matthew [1902b, pp. 391–392]	Acrothyra sera.
prima [Acrotreta papillata], Matthew [1903, pp. 73–74]	Do.
prima [Lingula], Billings [1856, p. 34]	Lingulella (Lingulepis) acuminata.
Emmons [1855, p. 202]	Lingulella prima.
Hall [1847, p. 3]	Do.
Hall [1851, p. 204]	Lingulella (Lingulepis) acuminata.
Hayden [1862, p. 73]	Probably equals Lingulella (Lingulepis) acuminata.
Owen [1851, p. 170]	Lingulella (Lingulepis) acuminata.
Rogers [1861, p. 390]	Obolus (Westonia) rogersi.
prima [Lingulella?], Hall and Clarke [1892c, p. 69]	Lingulella prima.
prima [Lingulepis], Grabau and Shimer [1907, p. 193]	Lingulella (Lingulepis) acuminata.
Meek and Hayden [1865, p. 3]	Dicellomus politus.
Miller [1877, p. 115]	Lingulella prima.
Schuchert [1897, p. 260]	Lingulella prima (in part).
prima [Meekina], Walcott [1905a, p. 313]	Linnarssonella tennesseensis.
prima [Obolella], Whitfield [1884, pp. 142–143]	Lingulella prima.
prima [Orbicula], Owen [1852, p. 583]	Lingulella (Lingulepis) acuminata.
Owen [1852, p. 583]	Obolus matinalis.
primaæa [Acrotreta], Walcott [1902, p. 593]	Acrotreta primæva.
primæva [Acrothele], Pompeckj [1896b, p. 603]	Acrothele primæva.
primæva [Discina (Orbicula)], de Verneuil and Barrande [1860, p. 532]	Do.
primæva [Lingulella], Davidson [1883, p. 208]	Lingulella? primæva.
Hicks [1871, p. 401]	Do.
Hicks [1881, p. 297]	Do.
Salter and Etheridge [1881, p. 538]	Do.
primordialis [Orthis], Mallada [1875, p. 31]	Eoorthis primordialis.
de Verneuil and Barrande [1860, pp. 532–533]	Do.
primordialis [Syntrophia], Hall and Clarke [1893b, p. 218]	Syntrophia primordialis.
Walcott [1905a, p. 292]	Do.
primordialis [Triplecia?], Hall and Clarke [1892c, p. 270]	Do.
primordialis [Triplesia], Whitfield [1878, p. 51]	Do.
Whitfield [1882, p. 172]	Do.
primordialis argia [Syntrophia], Walcott [1905a, p. 293]	Syntrophia primordialis argia.
primus [Obolus lens], Matthew [1902c, pp. 94–95]	Obolus (Palæobolus) bretonensis lens.
primus [Obolus (Lingulepis)], Walcott [1901, p. 673]	Lingulella prima.
prindlei [Obolus (Lingulella)], Walcott [1898b, p. 412]	Obolus prindlei.
priscus [Schizambon], Matthew [1901a, pp. 277–278]	Schizambon priscus.
Matthew [1903, pp. 187–189]	Do.
pristinus [Obolus], Matthew [1895a, pp. 121–122]	Trematobolus pristinus.
Matthew [1902c, p. 96]	Do.
proavia [Acrothyra], Matthew [1902b, pp. 386–388]	Acrothyra proavia.
Matthew [1903, pp. 53–55]	Do.
proavia [Acrotreta], Matthew [1899b, p. 203]	Do.
proavia crassa [Acrothyra], Matthew [1902b, pp. 389–390]	Do.
Matthew [1903, p. 94]	Do.
proavia prima [Acrothyra], Matthew [1901b, p. 303]	Do.
Matthew [1902b, p. 389]	Do.
Matthew [1903, pp. 58, 86, and 93]	Do.
producta [Lingula?], Moberg and Segerberg [1906, p. 63]	Lingulella lepis.
proles [Acrothele], Matthew [1902b, pp. 400–401]	Acrothele proles.
Matthew [1903, pp. 60 and 102–103]	Do.
prolificus [Dicellomus], Walcott [1908d, p. 77]	Dicellomus prolificus.
prospectensis [Iphidea], Schuchert [1897, p. 234]	Micromitra (Paterina) prospectensis.
prospectensis [Iphidella], Walcott [1905a, p. 307]	Do.

	Present reference.
prospectensis [Kutorgina], Walcott [1884b, p. 19]	Micromitra (Paterina) prospectensis.
Walcott [1886b, pp. 106–107]	Do.
Walcott [1891a, p. 610]	Do.
Protorhyncha? antiquata Schuchert [1897, p. 334]	Swantonia antiquata.
Protorhyncha? minor Schuchert [1897, p. 334]	Obolella minor.
Protorthis Grabau and Shimer [1907, p. 211]	Protorthis.
Hall and Clarke [1892a, pp. 273–274]	Do.
Hall and Clarke [1892b, pp. 589–590]	Do.
Hall and Clarke [1892c, pp. 231–233]	Do.
Walcott [1905a, pp. 280–281]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 147]	Do.
Protorthis billingsi Hall and Clarke [1892a, p. 274]	Protorthis billingsi.
Hall and Clarke [1892c, pp. 219 and 232]	Do.
Walcott [1905a, pp. 281–282]	Do.
(Protorthis) billingsi [Orthis], Wysogórski [1900, p. 227]	Do.
Protorthis? eurekensis Hall and Clarke [1892c, p. 232]	Orusia? eurekensis.
Protorthis helena Walcott [1905a, p. 282]	Protorthis helena.
Protorthis? hunnebergensis Moberg and Segerberg [1906, pp. 70–71]	Protorthis? hunnebergensis.
Protorthis lævis Walcott [1905a, p. 283]	Protorthis lævis.
Protorthis latourensis Walcott [1905a, pp. 282–283]	Protorthis latourensis.
Protorthis nautes Walcott [1905a, pp. 283–284]	Nisusia (Jamesella) nautes.
Protorthis? nunnebergensis Walcott [1905a, p. 284]	Protorthis? hunnebergensis.
Protorthis quacoensis Hall and Clarke [1892c, p. 232]	Protorthis quacoensis.
Walcott [1905a, pp. 284–285]	Do.
Protorthis spencei Walcott [1905a, p. 285]	Nisusia (Jamesella) spencei.
Protorthis wingi Walcott [1905a, p. 286]	Protorthis wingi.
Protorthis sp. undt. Walcott [1905a, p. 286]	Protorthis sp. undt.
Protorthis (Billingsella) billingsi Grabau and Shimer [1907, p. 211]	Protorthis billingsi.
Protorthis (Loperia) Walcott [1905a, p. 287]	Protorthis (Loperia).
Walcott [1908e, Pl. XI, and pp. 142 and 147]	Do.
Protorthis (Loperia) dougaldensis Walcott [1905a, pp. 287–288]	Protorthis (Loperia) dugaldensis.
Protosiphon Matthew [1897a, pp. 68–69]	Trematobolus.
Matthew [1898a, pp. 129–130]	Do.
Protosiphon kempanum Matthew [1897a, pp. 70–71]	Trematobolus kempanum.
Matthew [1898a, p. 131]	Do.
pulcher [Obolus?], Hall and Clarke [1892c, pp. 81 and 183]	Botsfordia pulchra.
pulcher [Obolus], Matthew [1889, p. 306]	Do.
Matthew [1890, pp. 151–155]	Do.
pulcher [Obolus (Botsfordia)], Matthew [1891, p. 148]	Do.
Matthew [1892, pp. 62–63]	Do.
Matthew [1902c, p. 95]	Do.
pulchra [Obolus (Botsfordia)], Matthew [1894, pp. 90–91]	Do.
Matthew [1895a, pp. 115–121]	Do.
pumila [Lingulepis], Matthew [1903, p. 75]	Lingulella (Lingulepis) pumila.
pumpellyi [Billingsella], Walcott [1905a, p. 242]	Billingsella pumpellyi.
punctatus [Obolus (Lingulella)], Walcott [1898b, pp. 412–413]	Lingulella punctata.
pusilla [Kutorgina cingulata], Grönwall [1902, p. 40]	Micromitra pusilla.
Linnarsson [1876, p. 25]	Do.
Matley [1902, pp. 146–147]	Do.
puteis [Acrothele avia], Matthew [1902b, p. 398]	Acrothele avia puteis.
Matthew [1903, p. 100]	Do.
pygmæa [Lingula], Davidson [1866, p. 53]	Lingulella (Lingulepis?) pygmæa.
Matley [1902, p. 141]	Do.
Phillips [1871, p. 68]	Do.
Salter [1865, p. 102]	Do.
pyxidicula [Acrotreta], White [1874, p. 9]	Acrotreta pyxidicula.
White [1877, pp. 53–54]	Do.

Q.

quacoensis [Billingsella], Schuchert [1897, p. 159]	Protorthis quacoensis.
quacoensis [Orthis], Matthew [1886, pp. 43–44]	Do.
quacoensis [Orthisina], Matthew [1891, p. 131]	Do.
quacoensis [Protorthis], Hall and Clarke [1892c, p. 232]	Do.
Walcott [1905a, pp. 284–285]	Do.

Present reference.

quadrilateralis [Obolus (Lingulella)], Walcott [1905a, p. 331]..... Lingulella quadrilateralis.
quadrilineata [Acrothele], Pompeckj [1896b, p. 511]..... Acrothele quadrilineata.
Quebecia Walcott [1905a, p. 320]..... Quebecia.
Walcott [1908e, Pl. XI, and pp. 142 and 145]..... Do.
Quebecia circe Walcott [1905a, pp. 320–321]..... Quebecia circe.
quenstedti [Obolus], Hall and Clarke [1892a, p. 243]..... Obolus apollinis quenstedti.
Hall and Clarke [1892b, p. 559]..... Do.
Hall and Clarke [1892c, p. 339]..... Do.
Matthew [1903, p. 120]..... Do.
Mickwitz [1892, p. 62]..... Do.
Walcott [1898b, p. 385]..... Do.
quenstedti [Obolus apollinis], Mickwitz [1896, pp. 143–145]..... Do.

R.

radula [Lingulella], Matthew [1891, pp. 147–148]..... Lingulella radula.
radula aspera [Lingulella], Matthew [1903, pp. 204–205]..... Do.
Rafinesquina? atava Schuchert [1897, p. 338]..... Eoorthis atava.
randomensis [Obolus (Lingulella)], Walcott [1901, pp. 688–689]..... Lingulella randomensis.
rara [Nisusia], Walcott [1908d, p. 97]..... Nisusia rara.
rarus [Acrothele], Walcott [1905a, pp. 303–304]..... Acrothele rara.
recurva [Acrotreta], Kutorga [1848, pp. 277–278]..... Volborthia recurva.
recurva [Volborthia], Hall and Clarke [1892a, figs. 261 and 262, p. 249]..... Do.
Hall and Clarke [1892b, figs. 261 and 262, p. 565]..... Do.
Hall and Clarke [1892c, pp. 95–96]..... Do.
von Möller [1874, pp. 449–452]..... Do.
(Redlichella) [Acrothele], Walcott [1908d, pp. 89–90]..... Acrothele (Redlichella).
Walcott [1908e, Pl. XI, and pp. 142 and 146]..... Do.
refulgens [Monobolina], Matthew [1903, pp. 210–213]..... Obolus refulgens.
refulgens [Obolus], Matthew [1892, pp. 44–45]..... Do.
Matthew [1902c, p. 96]..... Do.
refulgens [Obolus?], Mickwitz [1896, pp. 23–24]..... Do.
refulgens [Obolus (Monobolina)], Matthew [1902c, p. 98]..... Do.
remnicha [Orthis?], Walcott [1899, pp. 451–452, Pl. LXI, figs. 3 and 3a;
Pl. LXII, figs. 1, 1c–d]..... Eoorthis remnicha. The text includes both E. remnicha and E. iddingsi.
Walcott [1899, pp. 451–452, Pl. LXII, figs. 1a–b]..... Eoorthis iddingsi. The text includes both E. iddingsi and E. remnicha.
remnicha [Orthis], N. H. Winchell [1886, pp. 317–318]..... Eoorthis remnicha.
remnicha [Orthis (Plectorthis)], Walcott [1905a, pp. 268–269]..... Do.
remnicha [Plectorthis], Grabau and Shimer [1907, p. 252]..... Do.
remnicha sulcata [Orthis (Plectorthis)], Walcott [1905a, p. 269]..... Eoorthis remnicha sulcata.
remnicha texana [Orthis (Plectorthis)], Walcott [1905a, p. 270]..... Eoorthis remnicha texana.
remnicha winfieldensis [Orthis (Plectorthis)], Walcott [1905a, p. 270]..... Eoorthis remnicha winfieldensis.
retroflexa [Billingsella], Matthew [1903, pp. 148–151]..... Billingsella retroflexa.
retroflexa [Clitambonites (Gonambonites) plana], Matthew [1895b, p. 267]..... Do.
retroflexa [Orthis (Plectorthis)], Walcott [1905a, pp. 270–271]..... Do.
retroflexus [Clitambonites planus], Schuchert [1897, p. 184]..... Do.
rhea [Obolus], Walcott [1898b, pp. 387–388]..... Obolus rhea.
richthofeni [Billingsella], Walcott [1905a, pp. 242–243]..... Billingsella richthofeni.
roberti [Lingulella], Matthew [1895b, pp. 256–257]..... Lingulella (Lingulepis) roberti.
roberti [Lingulepis], Matthew [1903, p. 132]..... Do.
robusta [Lingulepis gregwa], Matthew [1903, pp. 57 and 131]..... Lingulella (Lingulepis) gregwa robusta.
rogersi [Lingulella], Grabau [1900, pp. 624–625]..... Obolus (Westonia) rogersi.
rogersi [Obolus (Lingulella)], Walcott [1898b, pp. 413–415]..... Do.
rogersi [Obolus (Westonia)], Walcott [1901, p. 691]..... Do.
rokitzanensis [Obolus?], Barrande [1879b, Pl. CXXVI]..... Obolus rokitzanensis.
romingeri [Billingsella], Walcott [1905a, pp. 243–244]..... Billingsella romingeri.
romingeri [Orthis], Barrande [1848, p. 203]..... Do.
Barrande [1879a, Pl. LXII, figs. II: 1–4]..... Do.
Feistmantel..... Nisusia (Jamesella) kuthani.
Jahn..... Do.
Katzer..... Do.
Krejci..... Do.

	Present reference.
romingeri [Orthis], Kusta	Nisusia (Jamesella) kuthani.
Novak	Do.
Pompeckj [1896b, pp. 513–514]	Billingsella romingeri.
Wentzel	Nisusia (Jamesella) kuthani.
rotunda [Lingulepis], Matthew [1903, p. 199]	Lingulella rotunda.
rotunda [Ungula], Pander [1830, pp. 59 and 163]	Obolus apollinis.
rotundata [Syntrophia], Walcott [1905a, pp. 293–294]	Syntrophia rotundata.
rotundatus [Obolus (Lingulella)], Walcott [1898b, p. 415]	Obolus rotundatus.
roualti [Lingula], Bornemann [1891, p. 439]	Kutorgina sardiniaensis.
rowei [Obolus (Lingulepis)], Walcott [1905a, p. 334]	Lingulella (Lingulepis) rowei.
rudis [Acrotreta], Walcott [1908d, pp. 95–96]	Acrotreta rudis.
rugatus [Obolus (Acritis?)], Walcott [1901, p. 694]	Obolus (Acritis?) rugatus.
rugosa [Schizopholis], Hall and Clarke [1892a, p. 248]	Schizopholis rugosa.
Hall and Clarke [1892b, p. 564]	Do.
Hall and Clarke [1892c, p. 95]	Do.
Waagen [1885, pp. 753–754]	Do.
Waagen [1891, Pl. II, figs. 12–14]	Do.
rugosicostata [Billingsella exporrecta], Walcott [1905a, p. 236]	Billingsella exporrecta rugosicostata.
rugosus [Acrotreta ophirensis], Walcott [1902, p. 592]	Acrotreta ophirensis rugosa.
Rustella Walcott [1905a, p. 311]	Rustella.
Walcott [1908e, Pl. XI, and pp. 142 and 143]	Do.
Rustella edsoni Walcott [1905a, pp. 311–312]	Rustella edsoni.

S.

sabrinæ [Acrotreta (?)], Matley [1902, p. 143]	Acrotreta sabrinæ.
sabrinæ [Metoptoma], Callaway [1874, p. 196]	Do.
sabrinæ [Obolella], Callaway [1877, p. 669]	Do.
Davidson [1883, p. 211]	Do.
Hall and Clarke [1892c, p. 103]	Do.
sabrinæ malvernensis [Acrotreta (?)], Matley [1902, pp. 143–144]	Do.
saffordi [Billingsella], Walcott [1905a, p. 244]	Wimanella saffordi.
sagittalis [Acrotreta cf.], Walcott [new]	Acrotreta cf. sagittalis.
sagittalis [Linnarssonia], Frech [1897, Pl. IA, fig. 3a]	Acrotreta sagittalis.
Hall and Clarke [1892c, p. 108]	Do.
Walcott [1885a, p. 115]	Do.
Walcott [1889c, p. 442]	Acrotreta depressa.
Walcott [1891a, Pl. LXVIII, figs. 2a–d]	Acrotreta sagittalis.
sagittalis [Obolella], Brögger [1882, p. 45]	Do.
Davidson [1868, pp. 309–310]	Do.
Davidson [1871, pp. 339–340]	Do.
Davidson [1883, p. 211]	Do.
Linnarsson [1876, pp. 19–20]	Do.
Linnarsson [1879, pp. 27–28]	Do.
Salter [1866a, p. 285]	Do.
sagittalis [Obolella cf.], Wiman [1902, p. 66]	Do.
sagittalis [Obolella (Acrotreta?)], Moberg and Segerberg [1906, p. 64]	Do.
sagittalis belti [Obolella], Davidson [1871, desc. of Pl. L, figs. 15–17]	Acrotreta belti.
sagittalis magna [Acrotreta], Walcott [1902, pp. 595–596]	Acrotreta sagittalis magna.
sagittalis taconica [Acrotreta], Walcott [1902, pp. 596–597]	Acrotreta sagittalis taconica.
sagittalis taconica [Linnarssonia], Walcott [1889b, p. 36]	Do.
Walcott [1891a, pp. 610–611]	Do.
sagittalis transversa [Linnarssonia], Frech [1897, Pl. IA, fig. 3b]	Acrotreta sagittalis transversa.
Walcott [1891a, desc. of Pl. LXVIII, figs. 2a, 2c–d]	Do.
salemensis [Billingsella], Walcott [1905a, p. 245]	Billingsella salemensis.
salemensis [Orthis], Oehlert [1889, p. 1139]	Do.
Walcott [1887, pp. 190–191]	Do.
Walcott [1891a, pp. 612–613]	Do.
saltensis [Orthis], Kayser [1876, p. 8]	Eoorthis saltensis.
Kayser [1897, p. 280]	Do.
saltensis [Orthis (Plectorthis)], Walcott [1905a, p. 271]	Do.
salteri [Obolella (?)], Davidson [1868, p. 311]	Obolus (Bröggeria) salteri.
salteri [Obolella], Holl [1865, p. 102]	Do.

	Present reference.
salteri [Obolella (?)], Matley [1902, pp. 139–140]	Obolus (Bröggeria) salteri.
salteri [Obolella], Phillips [1871, p. 68]	Do.
salteri? [Obolella], Davidson [1866, pp. 61–62]	Do.
salteri [Obolus], Brögger [1882, pp. 44–45]	Do.
salteri [Obolus?], Dall [1870, p. 163]	Do.
Mickwitz [1896, p. 19]	Do.
salteri [Obolus (Bröggeria)], Moberg and Segerberg [1906, p. 64]	Do.
Walcott [1902, pp. 605–606]	Do.
salteri var.? [Obolus (Bröggeria)], Westergård [1909, p. 56]	Do.
sandbergi [Billingsella (Otusia)], Walcott [1905a, pp. 246–247]	Otusia sandbergi.
sandbergi [Orthis (?)], Walcott [1899, pp. 452–453]	Do.
sandbergi [Orthis], N. H. Winchell [1886, p. 318]	Do.
sardiniaensis [Kutorgina], Walcott [1901, p. 695]	Kutorgina sardiniaensis.
Walcott [1905a, p. 311]	Do.
scabrinæ [Obolella?], Walcott [1884b, Pl. I, fig. 1c]	Acrotreta sabrinæ.
Schizambon Hall and Clarke [1892a, pp. 253–254]	Schizambon.
Hall and Clarke [1892b, pp. 569–570]	Do.
Hall and Clarke [1892c, pp. 113–117]	Do.
Walcott [1884b, pp. 69–70]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 146]	Do.
Winchell and Schuchert [1895, p. 360]	Do.
Schizambon ? esthonia Walcott [new]	Schizambon ? esthonia.
Schizambon manitouensis Walcott [new]	Schizambon manitouensis.
Schizambon priscus Matthew [1901a, pp. 277–278]	Schizambon priscus.
Matthew [1903, pp. 187–189]	Do.
Schizambon typicalis Hall and Clarke [1892a, p. 253]	Schizambon typicalis.
Hall and Clarke [1892c, pp. 114, 116, and 117]	Do.
Walcott [1884b, pp. 70–71]	Do.
Schizambonia Oehlert [1887, p. 1266]	Schizambon.
Schizopholis Hall and Clarke [1892a, p. 248]	Schizopholis.
Hall and Clarke [1892b, p. 564]	Do.
Hall and Clarke [1892c, p. 94]	Do.
Oehlert [1887, p. 1267]	Do.
Waagen [1885a, p. 752]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 145]	Do.
Schizopholis rugosa Hall and Clarke [1892a, p. 248]	Schizopholis rugosa.
Hall and Clarke [1892b, p. 564]	Do.
Hall and Clarke [1892c, p. 95]	Do.
Waagen [1885a, pp. 753–754]	Do.
Waagen [1891, Pl. II, figs. 12–14]	Do.
schmalenseei [Acrotreta], Walcott [1902, pp. 597–598]	Acrotreta schmalenseei.
schmalenseei [Obolus (Lingulella)], Walcott [1902, p. 605]	Obolus schmalenseei.
schmidti [Obolus], Mickwitz [1896, pp. 152–154]	Obolus schmidti.
Schmidtia Balsamo-Crivelli [1863]	A genus of the Porifera.
Schmidtia Dall [1877, p. 62]	Obolus (Schmidtia).
Hall and Clarke [1892a, p. 244]	Do.
Hall and Clarke [1892b, p. 560]	Do.
Hall and Clarke [1892c, p. 83]	Do.
Oehlert [1867, p. 1261]	Do.
Volborth [1869, pp. 208–209]	Do.
Zittel [1880, p. 665]	Dicellomus (in part) and Obolus (Schmidtia) (in part).
(Schmidtia) [Obolus], Mickwitz [1896, p. 158]	Obolus (Schmidtia).
Walcott [1901, p. 683]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
(Schmidtia) acuminatus [Obolus], Mickwitz [1896, pp. 179–183]	Obolus (Schmidtia) acuminatus.
(Schmidtia) acuminatus alatus [Obolus], Mickwitz [1896, pp. 183–184]	Do.
(Schmidtia) acuminatus humeratus [Obolus], Mickwitz [1896, pp. 184–186]	Do.
(Schmidtia) acuminatus subtriangularis [Obolus], Mickwitz [1896, pp. 186–187]	Do.
Schmidtia celata Hall and Clarke [1892a, p. 244]	Obolus (Schmidtia) celatus.
Hall and Clarke [1892b, p. 560]	Do.
Hall and Clarke [1892c, p. 83]	Do.
Volborth [1869, pp. 209–212]	Do.

	Present reference.
(Schmidtia) celatus [Obolus], Mickwitz [1896, pp. 159–163]	Obolus (Schmidtia) celatus.
(Schmidtia) celatus orbiculatus [Obolus], Mickwitz [1896, pp. 163–165]	Do.
(Schmidtia) celatus præcisus [Obolus], Mickwitz [1896, pp. 166–167]	Do.
Schmidtia?? complexus Mickwitz [1896, pp. 19–20]	Obolus complexus.
(Schmidtia) crassus [Obolus], Mickwitz [1896, pp. 187–193]	Obolus (Schmidtia) crassus.
(Schmidtia) crassus angulatus [Obolus], Mickwitz [1896, pp. 193–194]	Do.
(Schmidtia) obtusus [Obolus], Mickwitz [1896, pp. 167–171]	Obolus (Schmidtia) obtusus.
(Schmidtia) obtusus acutus [Obolus], Mickwitz [1896, pp. 172–173]	Do.
(Schmidtia) obtusus ellipticus [Obolus], Mickwitz [1896, pp. 177–178]	Do.
(Schmidtia) obtusus extenuatus [Obolus], Mickwitz [1896, pp. 178–179]	Do.
(Schmidtia) obtusus latus [Obolus], Mickwitz [1896, pp. 174–175]	Do.
(Schmidtia) obtusus longus [Obolus], Mickwitz [1896, pp. 171–172]	Do.
(Schmidtia) obtusus minutus [Obolus], Mickwitz [1896, pp. 175–177]	Do.
schucherti [Obolus (Lingulella)], Walcott [1901, pp. 689–690]	Lingulella schucherti.
Schuchertina Walcott [1905a, p. 323]	Schuchertina.
Walcott [1908e, Pl. XI, and pp. 142 and 145]	Do.
Schuchertina cambria Walcott [1905a, pp. 323–324]	Schuchertina cambria.
scotica [Micromitra], Walcott [new]	Micromitra scotica.
sculpta [Aulonotreta], Dall [1877, p. 16]	Obolus (Acritis) antiquissimus.
Kutorga [1848, pp. 282–283]	Do.
sculptilis [Iphidea (??)], Meek [1873, p. 479]	Micromitra sculptilis.
sculptilis [Iphidea], Schuchert [1897, p. 235]	Do.
Walcott [1899, pp. 447–448]	Do.
sculptilis [Iphidella], Walcott [1905a, p. 308]	Do.
sculptilis [Kutorgina], Walcott [1884b, p. 20]	Do.
sculptilis endlichi [Micromitra], Walcott [1908d, p. 56]	Micromitra sculptilis endlichi.
seebachi [Acrotreta], Moberg and Segerberg [1906, pp. 66–67]	Acrotreta seebachi.
Walcott [1902, pp. 598–599]	Do.
selwyni [Lingulella], Matthew [1895b, pp. 255–256]	Obolus selwyni.
Matthew [1903, pp. 62–63]	Do.
Matthew [1903, pp. 116–123]	Do.
septalis [Obolus (Lingulella)], Walcott [1905a, p. 331]	Obolus septalis.
sequens [Lingulella (Lingulepis) acuminata], Walcott [1908d, p. 72]	Lingulella (Lingulepis) acuminata sequens.
sera [Acrothyra (signata)], Matthew [1902b, pp. 383–384]	Acrothyra sera.
sera [Acrothyra signata], Matthew [1903, p. 56]	Do.
Matthew [1903, pp. 87–88]	Do.
shantungensis [Acrotreta], Walcott [1905a, pp. 301–302]	Acrotreta shantungensis.
shelbyensis [Wimanella], Walcott [1908d, p. 100]	Wimanella shelbyensis.
shensiensis [Obolus], Walcott [1905a, p. 327]	Obolus shansiensis.
siemiradzkii [Obolus (Lingulella)], Walcott [1901, pp. 690–691]	Lingulella siemiradzkii.
signalis [Acrotreta], Walcott [1902, p. 599]	Acrotreta signalis.
signata [Acrothyra], Matthew [1902b, pp. 381–382]	Acrothyra signata.
Matthew [1903, p. 87]	Do.
signata [Lingula?], Barrande [1868a, p. 103]	Lingulella signata.
Barrande [1868b, p. 692]	Do.
signata orta [Acrothyra], Matthew [1902b, pp. 385–386]	Acrothyra signata orta.
Matthew [1903, pp. 89–90]	Do.
signata prima [Acrothyra], Matthew [1902b, pp. 382–383]	Acrothyra signata prima.
Matthew [1903, p. 73]	Do.
(signata) sera [Acrothyra], Matthew [1902b, pp. 383–384]	Acrothyra sera.
signata sera [Acrothyra], Matthew [1903, p. 56]	Do.
Matthew [1903, pp. 87–88]	Do.
signata tarda [Acrothyra], Matthew [1902b, pp. 384–385]	Do.
Matthew [1903, p. 89]	Do.
siluricus [Obolus], Eichwald [1843a, pp. 7–8]	Obolus (Mickwitzella) siluricus.
Eichwald [1859, Pl. XXXVII, figs. 6 and 7a–b]	Do.
Eichwald [1860, pp. 927–928]	Do.
Mickwitz [1892, p. 60]	Do.
Schmidt [1861, p. 218]	Do.
Schmidt [1881, p. 17]	Do.
Siemiradzki [1886, p. 672]	Obolus (Acritis) antiquissimus.
siluricus [Obolus (Thysanotos)], Mickwitz [1896, pp. 195–199]	Obolus (Mickwitzella) siluricus.
similis [Obolus (Lingulella)], Walcott [1898b, pp. 415–416]	Lingulella similis.
simplex [Lingula], Barrande [1879b, Pl. CIV, figs. VI: 1–4]	Lingulella? simplex.

	Present reference.
simplex [Wimanella], Walcott [1908d, p. 101]	Wimanella simplex.
sinoe [Obolus (Lingulella)], Walcott [1898b, pp. 416–417]	Obolus sinoe.
Siphonotreta Davidson [1853, pp. 131–133]	Siphonotreta.
Davidson [1866, p. 75]	Do.
Davidson [1877, pp. 13–16]	Do.
Davidson [1883, pp. 217–219]	Do.
Eichwald [1860, p. 915]	Do.
Hall and Clarke [1892a, pp. 252–253]	Do.
Hall and Clarke [1892b, pp. 568–569]	Do.
Hall and Clarke [1892c, pp. 110–113]	Do.
Jeremejew [1856, pp. 73 and 80]	Helmersenia.
Kutorga [1848, pp. 261–263]	Siphonotreta.
Morris [1849, pp. 315–320]	Do.
Morris [1850, pp. 57–58]	Do.
Oehlert [1887, p. 1265]	Do.
Quenstedt [1871, pp. 673–674]	Do.
Seebach [1865, p. 341]	Do.
de Verneuil [1845, p. 286]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 146]	Do.
Winchell and Schuchert [1895, p. 358]	Do.
Zittel [1880, pp. 665–666]	Do.
Siphonotreta ? dubia Walcott [new]	Siphonotreta ? dubia.
Siphonotreta ladogensis Jeremejew [1856, pp. 73 and 80]	Helmersenia ladogensis.
Siphonotreta unguiculata Davidson [1853, Pl. IX, figs. 261–265, 269, and 270]	Siphonotreta unguiculata.
Davidson [1877, pp. 14 and 15]	Do.
Eichwald [1860, pp. 915–916]	Do.
Gagel [1890, p. 23]	Do.
Hall and Clarke [1892a, p. 253]	Do.
Hall and Clarke [1892c, p. 111]	Do.
Kutorga [1848, pp. 264 and 284]	Do.
Quenstedt [1871, p. 674]	Do.
Quenstedt [1885, p. 755]	Do.
Schmidt [1861, p. 218]	Do.
de Verneuil [1845, pp. 286–287]	Do.
Walcott [1884b, p. 16]	Do.
Zittel [1880, p. 666]	Do.
Siphonotreta unguiculata var. α Kutorga [1848, p. 284]	Do.
Siphonotreta unguiculata var. β Kutorga [1848, pp. 264–265]	Do.
Siphonotreta unguiculata var. γ elongata Kutorga [1848, p. 265]	Do.
Siphonotreta verrucosa Davidson [1853, Pl. IX, figs. 267 and 268]	Siphonotreta verrucosa.
Eichwald [1860, pp. 916–917]	Do.
Gagel [1890, p. 22]	Do.
Kutorga [1848, pp. 266–267]	Do.
Morris [1849, Pl. VII, figs. 2a–d]	Do.
Quenstedt [1871, p. 674]	Do.
Quenstedt [1885, p. 755]	Do.
Schmidt [1861, p. 218]	Do.
de Verneuil [1845, p. 287]	Do.
sipo [Acrotreta], Matthew [1902h, pp. 406–407]	Acrotreta bisecta.
Matthew [1903, pp. 185–186]	Do.
smithi [Obolus], Walcott [1908d, pp. 62–63, Pl. VII, fig. 9a]	Obolus smithi.
Walcott [1908d, Pl. VII, fig. 9]	Micromitra (Paterina) major.
socialis [Acrotreta], Grönwall [1902, p. 39]	Either Acrotreta schmalenseei or A. socialis. (See p. 712.)
Linnarsson [1876, pp. 16–18]	Acrotreta schmalenseei.
Linnarsson [1877, p. 374]	Either Acrotreta schmalenseei or A. socialis. (See p. 712.)
von Seebach [1865, p. 341]	Acrotreta socialis.
Walcott [1902, pp. 599–600]	Do.
Wallerius [1895, p. 66]	Acrotreta schmalenseei.
socialis [Acrotreta cf.], Brögger [1882, pp. 46–47, Pl. X, figs. 2, 2a–b]	Acrotreta carinata.
Brögger [1882, pp. 46–47, Pl. X, figs. 3 and 4]	Not referred in this monograph.
Matley [1902, pp. 144–145]	Acrotreta sabrinæ.

	Present reference.
socialis [Acrotreta cf.], Matthew [1902b, pp. 392–394]	Acrotreta sp. undt., not A. socialis.
Matthew [1903, pp. 183–185]	Do.
solidus [Obolus (Leptembolon) lingulæformis], Mickwitz [1896, pp. 204–205]	Lingulella (Leptembolon) lingulæformis.
spatulus [Obolus (Lingulella)], Walcott [1902, p. 607]	Lingulella (Lingulepis) spatula.
spencei [Protorthis], Walcott [1905a, p. 285]	Nisusia (Jamesella) spencei.
Sphærobolus Matthew [1895b, p. 263]	Obolus (Lingulobolus).
Sphærobolus spissus Grabau [1900, pp. 622–623]	Obolus (Lingulobolus) spissus.
Matthew [1895b, pp. 263–266]	Do.
spinosa [Acrotreta], Walcott [1905a, p. 302]	Acrotreta spinosa.
Spirifera? lenticularis von Buch [1834, p. 48]	Orusia lenticularis.
spissa [Lingulella?], Billings [1872b, pp. 468–469]	Obolus (Lingulobolus) spissus.
Billings [1874, pp. 67–68]	Do.
Billings [1882, p. 15]	Do.
spissus [Obolus (Lingulobolus)], Walcott [1898a, p. 327]	Do.
spissus [Sphærobolus], Grabau [1900, pp. 622–623]	Do.
Matthew [1895b, pp. 263–266]	Do.
spurri [Acrothele], Walcott [1908d, pp. 86–87]	Acrothele spurri.
squama [Davidsonella], Waagen [1885, pp. 766–767]	Neobolus warthi.
squamosa [?Lingula], Davidson [1866, p. 41]	Lingulella (Lingulepis?) squamosa.
squamosa [Lingula], Holl [1865, p. 102]	Do.
starri [Lingulella], Matthew [1891, pp. 146–147]	Lingulella (Lingulepis) starri.
starri [Lingulepis], Matthew [1903, p. 195]	Do.
starri exigua [Lingulepis], Matthew [1903, pp. 197–198]	Lingulella (Lingulepis) exigua.
starri minor [Lingulella], Matthew [1892, pp. 58–59]	Lingulella minor.
starri var. [Lingulepis], Matthew [1903, pp. 193–197]	Lingulella (Lingulepis) exigua.
stissingensis [Iphidea], Schuchert [1897, p. 234]	Micromitra (Paterina) stissingensis.
stissingensis [Iphidella], Walcott [1905a, p. 308]	Do.
stissingensis [Kutorgina], Dwight [1889, pp. 145–147]	Do.
Dwight [1891, p. 105]	Do.
stissingensis ora [Micromitra (Paterina)], Walcott [new]	Micromitra (Paterina) stissingensis ora.
stoneana [Lingulella], Hall and Clarke [1892c, Pl. II, figs. 9–11]	Obolus (Westonia) stoneanus.
Weller [1903, p. 112]	Do.
Whitfield [1882, pp. 344–345]	Do.
stoneanus [Obolus (Westonia)], Walcott [1901, p. 691]	Do.
striata [Billingsella], Walcott [1905a, p. 245]	Billingsella striata.
Strophomena atava Matthew [1893b, pp. 102–103]	Eoorthis atava.
Strophomena? atava Moberg and Segerberg [1906, Pl. II, figs. 7, 7a–b]	Do.
Strophomena (Eostrophomena) Walcott [1905a, p. 256]	Eostrophomena.
Strophomena (Eostrophomena) elegantula Walcott [1905a, pp. 256–257]	Eostrophomena elegantula.
Strophomena (Eostrophomena) walcotti Moberg and Segerberg [1906, p. 71]	Do.
strophomenoides [Orthis lenticularis], Matthew [1892, p. 49]	Orusia lenticularis.
Matthew [1903, p. 217]	Do.
stuarti [Micromitra (Paterina)], Walcott [1908d, p. 58]	Micromitra (Paterina) stuarti.
subconica [Acrotreta], Davidson [1853, Pl. IX, figs. 271–275]	Acrotreta subconica.
Kutorga [1848, p. 275]	Do.
Meek [1873, p. 463]	Acrotreta attenuata (in part), A. attenuata var. (in part), and A. idahoensis (in part).
Quenstedt [1885, p. 755]	Acrotreta subconica.
von Seebach [1865, p. 341]	Do.
Walcott [1902, pp. 600–601]	Do.
subquadrata [Nisusia (Jamesella) perpasta], Walcott [1905a, p. 255]	Nisusia (Jamesella) perpasta subquadrata.
subquadrata [Orthis perpasta], Pompeckj [1896b, p. 516]	Do.
subsidua [Acrothele], Beecher [1891, Pl. XVII, fig. 12]	Acrothele subsidua.
Grabau and Shimer [1907, p. 200]	Do.
Hall and Clarke [1892c, pp. 100 and 103]	Do.
Matthew [1902c, p. 110]	Do.
Matthew [1903, p. 103]	Acrothele spurri.
Walcott [1886b, pp. 108–109, Pl. IX, figs. 4a–c]	Acrothele subsidua. The paragraph on page 109 includes reference to this species and to Acrothele spurri.
Walcott [1886b, p. 109, Pl. IX, fig. 4]	Acrothele spurri. The paragraph on page 109 includes reference to this species and to Acrothele subsidua.

	Present reference.
subsidua [Acrothele], Walcott [1891a, p. 608, Pl. LXX, fig. 1]	Acrothele spurri. The text includes reference to this species and to Acrothele subsidua.
Walcott [1891a, pp. 608–609, Pl. LXX, figs. 1a–c]	Acrothele subsidua. The text includes reference to this species and to Acrothele spurri.
White [1880, p. 47]	Acrothele subsidua.
subsidua [Acrotreta?], White [1874, p. 6]	Do.
White [1877, pp. 34–36]	Do.
subsidua hera [Acrothele], Walcott [1908d, p. 87]	Acrothele subsidua hera.
subsidua lævis [Acrothele], Walcott [new]	Acrothele subsidua lævis.
subtriangularis [Obolus (Schmidtia) acuminatus], Mickwitz [1896, pp. 186–187]	Obolus (Schmidtia) acuminatus.
sulcata [Acrotreta idahoensis], Walcott [1902, p. 588]	Acrotreta idahoensis sulcata.
sulcata [Crania], Eichwald [1829, p. 274]	Siphonotreta unguiculata.
sulcata [Orthis (Plectorthis) remnicha], Walcott [1905a, p. 269]	Eoorthis remnicha sulcata.
sulcatus [Discinopsis], Walcott [1906, pp. 568–569]	Discinopsis? sulcatus.
superba [Iphidea], Walcott [1897b, p. 711]	Micromitra (Paterina) superba.
swantonensis [Iphidea], Grabau and Shimer [1907, p. 201]	Micromitra (Paterina) labradorica swantonensis.
swantonensis [Iphidea labradorica], Schuchert [1897, p. 234]	Do.
swantonensis [Iphidella labradorica], Walcott [1905a, p. 307]	Do.
swantonensis [Kutorgina labradorica], Walcott [1890b, p. 36]	Do.
Walcott [1891a, p. 609]	Do.
Swantonia Walcott [1905a, p. 296]	Swantonia.
Walcott [1908e, Pl. XI, and pp. 142 and 148]	Do.
Swantonia antiquata Walcott [1905a, pp. 296–297]	Swantonia antiquata.
Swantonia weeksi Walcott [1905a, p. 297]	Swantonia weeksi.
Syntrophia Grabau and Shimer [1907, p. 270]	Syntrophia.
Hall and Clarke [1892c, p. 270]	Do.
Hall and Clarke [1893b, pp. 216–218]	Do.
Hall and Clarke [1894a, p. 836]	Do.
Walcott [1905a, pp. 288–289]	Syntrophia (in part) and Huenella (in part).
Walcott [1908e, Pl. XI, and pp. 142 and 148]	Syntrophia.
Syntrophia abnormis Walcott [1905a, pp. 289–290]	Huenella abnormis.
Syntrophia alata Walcott [1905a, p. 290]	Syntrophia alata.
Syntrophia barabuensis Hall and Clarke [1893b, p. 216]	Syntrophia barabuensis.
Walcott [1905a, pp. 290–291]	Do.
Syntrophia billingsi Walcott [1905a, pp. 291–292]	Huenella billingsi.
Syntrophia calcifera Grabau and Shimer [1907, p. 271]	Syntrophia nundina.
Syntrophia? calcifera Hall and Clarke [1893b, p. 218]	Syntrophia calcifera.
Syntrophia cambria Walcott [1908d, pp. 106–107]	Syntrophia cambria.
Syntrophia campbelli Walcott [1908d, pp. 107–108]	Syntrophia campbelli.
Syntrophia lateralis Hall and Clarke [1892c, p. 270]	Syntrophia lateralis.
Hall and Clarke [1893b, p. 217]	Do.
Hall [1894a, p. 837]	Do.
Syntrophia nundina Walcott [1905a, p. 292]	Syntrophia nundina.
Syntrophia orientalis Walcott [1905a, p. 292]	Huenella orientalis.
Syntrophia orthia Walcott [1905b, pp. 11–12]	Syntrophia orthia.
Syntrophia primordialis Hall and Clarke [1893b, p. 218]	Syntrophia primordialis.
Walcott [1905a, p. 292]	Do.
Syntrophia primordialis argia Walcott [1905a, p. 293]	Syntrophia primordialis argia.
Syntrophia rotundata Walcott [1905a, pp. 293–294]	Syntrophia rotundata.
Syntrophia texana Walcott [1905a, p. 294]	Huenella texana.
Syntrophia texana læviusculus Walcott [1905a, pp. 294–295]	Huenella texana læviusculus.
Syntrophia? unxia Walcott [1908d, pp. 108–109]	Syntrophia? unxia.

T.

taconica [Acrotreta sagittalis], Walcott [1902, pp. 596–597]	Acrotreta sagittalis taconica.
taconica [Linnarssonia], Oehlert [1889, p. 1138]	Do.
Walcott [1887, pp. 189–190]	Do.
taconica [Linnarssonia sagittalis], Walcott [1889b, p. 36]	Do.
Walcott [1891a, pp. 610–611]	Do.
tarda [Acrothyra signata], Matthew [1902b, pp. 384–385]	Acrothyra sera.

	Present reference.
tarda [Acrothyra signata], Matthew [1903, p. 89]	Acrothyra sera.
tarpa [Obolus (Lingulella)], Walcott [1898b, pp. 417–418]	Lingulella tarpa.
tatei [Orthis (?)], Etheridge, jr. [1905, p. 249]	Eoorthis tatei.
Tellinomya McCoy [1854, p. 274]	Lingulella.
Tellinomya lingulæ-comes McCoy [1851a, p. 56]	Lingulella davisi.
Salter	Does not equal Lingulella davisi.
Tellinomya lingulicomes McCoy [1854, p. 274]	Lingulella davisi.
tennesseensis [Linnarssonella], Walcott [1902, pp. 604–605]	Linnarssonella tennesseensis.
Terebratula Eichwald [1840, p. 138 (24)]	Siphonotreta (in part).
Eichwald [1843b, p. 145]	Siphonotreta.
Terebratula unguiculata Eichwald [1840, pp. 138–140 (24–26)]	Siphonotreta unguiculata.
Eichwald [1842, p. 145]	Do.
Terebratula verrucosa Eichwald [1840, pp. 140–141 (26–27)]	Siphonotreta verrucosa.
tetonensis [Acrotreta microscopica], Walcott [1902, p. 590]	Acrotreta microscopica tetonensis.
tetonensis [Obolus], Walcott [1901, p. 684]	Obolus tetonensis.
Walcott [1905a, p. 327]	Do.
tetonensis leda [Obolus], Walcott [1908d, p. 63]	Obolus tetonensis leda.
tetonensis ninus [Obolus], Walcott [1905a, p. 328]	Obolus tetonensis ninus.
texana [Lingulella], Walcott [1908d, p. 71]	Lingulella texana.
texana [Orthis (Plectorthis) remnicha], Walcott [1905a, p. 270]	Eoorthis remnicha texana.
texana [Syntrophia], Walcott [1905a, p. 294]	Huenella texana.
texana læviusculus [Syntrophia], Walcott [1905a, pp. 294–295]	Huenella texana læviusculus.
themis [Obolus (Westonia)], Walcott [1905a, pp. 336–337]	Obolus (Westonia) themis.
thyone [Eoorthis], Walcott [1908d, pp. 105–106]	Eoorthis thyone.
Thysanota Albers [1860, p. 63]	A genus of the Gastropoda.
(Thysanotos) [Obolus], Mickwitz [1896, pp. 194–195]	Obolus (Mickwitzella).
(Thysanotos) siluricus [Obolus], Mickwitz [1896, pp. 195–199]	Obolus (Mickwitzella) siluricus.
(Thysanotus) [Obolus], Walcott [1901, p. 683]	Obolus (Mickwitzella).
torrentis [Leptobolus], Matthew [1903, pp. 74–75]	Lingulella torrentis.
torrentis [Obolus], Matthew [1902c, p. 94]	Obolus? torrentis.
Matthew [1903, p. 76]	Do.
transversa [Linnarssonella], Walcott [1908d, p. 92]	Linnarssonella transversa.
transversa [Linnarssonia], Hall and Clarke [1892a, Pl. III, figs. 22 and 23]	Acrotreta sagittalis transversa.
Hall and Clarke [1892c, p. 108]	Do.
Matthew [1886, p. 35]	Do.
Matthew [1895a, p. 125]	Do.
Walcott [1885a, p. 115]	Do.
transversa [Linnarssonia sagittalis], Frech [1897, Pl. IA, fig. 3b]	Do.
Walcott [1891a, desc. of Pl. LXVIII, figs. 2a, 2c, and 2d]	Do.
transversa [Nisusia festinata], Walcott [1905a, p. 251]	Nisusia festinata transversa.
transversa [Obolella], Hartt [1868, p. 644]	Acrotreta sagittalis transversa.
Hartt [1878, p. 644]	Do.
Hartt [1891, p. 644]	Do.
Walcott [1884a, p. 16]	Do.
transversa [Orthisina?], Walcott [1886b, p. 121]	Nisusia festinata transversa.
Walcott [1891a, p. 613]	Do.
transversa [Ungula], Pander [1830, pp. 59 and 154, Pl. III, fig. 24]	Obolus apollinis quenstedti.
Pander [1830, pp. 59 and 163, Pl. XXVIII, figs. 7a–b and 8a–b?]	Obolus apollinis. The text includes also Obolus apollinis quenstedti.
Trematis pannulus White [1874, p. 6]	Micromitra (Ipbidella) pannula.
White [1877, pp. 36–37]	Do.
Trematobolus Hall and Clarke [1892a, p. 252]	Trematobolus.
Hall and Clarke [1892b, p. 568]	Do.
Matthew [1893a, pp. 276–279]	Do.
Matthew [1894, pp. 88–90]	Do.
Matthew [1895a, pp. 122–125]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 146]	Do.
Trematobolus excelsis Walcott [1908d, pp. 80–81]	Trematobolus excelsis.
Trematobolus insignis Hall and Clarke [1892a, p. 252]	Trematobolus insignis.
Hall and Clarke [1892b, p. 568]	Do.
Matthew [1893a, pp. 276–279]	Do.
Matthew [1894, pp. 88–90]	Do.

	Present reference.
Trematobolus insignis Matthew [1895a, pp. 122–125]	Trematobolus insignis.
Matthew [1895c, p. 95]	Do.
Matthew [1898, p. 35]	Do.
triangularis [Obolus], Mickwitz [1896, pp. 145–147]	Obolus triangularis.
Moberg and Segerberg [1906, p. 65]	Do.
Westergård [1909, p. 56]	Do.
triangularis [Ungula], Pander [1830, pp. 59, 154, and 163]	Obolus apollinis.
triangularis inornatus [Obolus], Mickwitz [1896, pp. 148–149]	Obolus triangularis.
triparilis [Obolus], Matthew [1902c, p. 94]	Lingulella triparilis.
triparilis [Obolus (Eoobolus)], Matthew [1903, pp. 136–137]	Do.
Triplecia? calcifera Hall and Clarke [1892c, p. 270]	Syntrophia calcifera.
Triplecia? primordialis Hall and Clarke [1892c, p. 270]	Syntrophia primordialis.
Triplesia calcifera Walcott [1884b, pp. 75–76]	Syntrophia nundina.
Triplesia lateralis Whitfield [1886, p. 303]	Syntrophia lateralis.
Triplesia primordialis Whitfield [1878, p. 51]	Syntrophia primordialis.
Whitfield [1882, p. 172]	Do.
tritavus [Leptobolus atavus], Matthew [1903, p. 109]	Lingulella torrentis.
tullbergi [Orthis (Plectorthis)], Moberg and Segerberg [1906, p. 69]	Eoorthis tullbergi.
Walcott [1905a, p. 271]	Do.
tumida [Lingulella], Matthew [1899b, p. 200]	Lingulella tumida.
Matthew [1903, p. 123]	Do.
turneri [Acrothele], Walcott [1908d, pp. 87–88]	Acrothele turneri.
typicalis [Schizambon], Hall and Clarke [1892a, p. 253]	Schizambon typicalis.
Hall and Clarke [1892c, pp. 114, 116, and 117]	Do.
Walcott [1884b, pp. 70–71]	Do.

U.

ulrichi [Acrotreta], Walcott [1908d, pp. 96–97]	Acrotreta ulrichi.
undosa [Kutorgina], Moberg [1892b, p. 112]	Micromitra (Paterina) undosa.
unguiculata [Crania], Eichwald [1829, p. 274]	Siphonotreta unguiculata.
unguiculata [Siphonotreta], Davidson [1853, Pl. IX, figs. 261–265, 269, and 270]	Do.
Davidson [1877, pp. 14 and 15]	Do.
Eichwald [1860, pp. 915–916]	Do.
Gagel [1890, p. 23]	Do.
Hall and Clarke [1892a, p. 253]	Do.
Hall and Clarke [1892c, p. 111]	Do.
Kutorga [1848, pp. 264 and 284]	Do.
Quenstedt [1871, p. 674]	Do.
Quenstedt [1885, p. 755]	Do.
Schmidt [1861, p. 218]	Do.
de Verneuil [1845, pp. 286–287]	Do.
Walcott [1884b, p. 16]	Do.
Zittel [1880, p. 666]	Do.
unguiculata var. α [Siphonotreta], Kutorga [1848, p. 284]	Do.
unguiculata var. β [Siphonotreta], Kutorga [1848, pp. 264–265]	Do.
unguiculata var. γ elongata [Siphonotreta], Kutorga [1848, p. 265]	Do.
unguiculata [Terebratula], Eichwald [1840, pp. 138–140 (24–26)]	Do.
Eichwald [1842, p. 145]	Do.
unguiculus [Lingulella], Salter [1866a, p. 285]	Lingulella ferruginea.
Ungula Dall [1877, p. 75]	Obolus.
Pander [1830, pp. 57–58]	Do.
Ungula convexa Pander [1830, pp. 59 and 163]	Obolus apollinis quenstedti.
Ungula ovata Pander [1830, p. 59, Pl. XXVIII, figs. 6a–b]	Obolus (Schmidtia) celatus.
Pander [1830, pp. 59 and 154, Pl. III, fig. 23]	Obolus apollinis.
Ungula plana Pander [1830, pp. 59 and 163]	Do.
Ungula plana or convexa Pander [1830, p. 163]	Do.
Ungula rotunda Pander [1830, pp. 59 and 163]	Do.
Ungula transversa Pander [1830, pp. 59 and 154, Pl. III, fig. 24]	Obolus apollinis quenstedti.
Pander [1830, pp. 59 and 163, Pl. XXVIII, figs. 7a–b and 8a–b?]	Obolus apollinis. The text includes also Obolus apollinis quenstedti.
Ungula triangularis Pander [1830, pp. 59, 154, and 163]	Obolus apollinis.
ungula [Orthis], von Buch [1841, pp. 7–8]	Do.

	Present reference.
Unguliten von Buch [1841, p. 7]	Obolus.
Pander [1830, pp. 55–58]	Do.
Quenstedt [1837, pp. 143–145]	Do.
Ungulites Quenstedt [1885, p. 756]	Do.
Ungulites apollinis Quenstedt [1885, pp. 755 and 756]	Obolus apollinis.
Ungulites sp. Quenstedt [1837, pp. 143–145]	Obolus apollinis quenstedti.
unxia [Syntrophia?], Walcott [1908d, pp. 108–109]	Syntrophia? unxia.
upis [Obolus (Lingulella)], Walcott [1905a, pp. 331–332]	Lingulella upis.
uplandensis [Acrotreta], Walcott [1905a, p. 302]	Acrotreta uplandica.
uplandica [Acrotreta], Wiman [1902, p. 54]	Do.
uplandica limonensis [Acrotreta], Walcott [1905a, p. 303]	Acrotreta uplandica limöensis.
urania [Linnarssonella], Walcott [1908d, pp. 92–93]	Linnarssonella urania.
utahensis [Iphidella labradorica], Walcott [1905a, p. 306]	Micromitra (Paterina) labradorica utahensis.
utahensis [Nisusia (Jamesella)], Walcott [1905a, pp. 255–256]	Nisusia (Jamesella) utahensis.
utahensis [Otusia], Walcott [new]	Otusia utahensis.

V.

varians [Discina], Barrande [1868a, pp. 103–104]	Orbiculoidea varians.
Barrande [1868b, p. 692]	Do.
Pompeckj [1896a, p. 4]	Do.
vaticina [Orthisina], Mallada [1875, p. 32]	Nisusia? vaticina.
de Verneuil and Barrande [1860, pp. 533–535]	Do.
ventrosus [Obolus (Acritis) antiquissimus], Mickwitz [1896, pp. 213–214]	Obolus (Acritis) antiquissimus.
vermilionensis [Obolella], Walcott [new]	Obolella vermilionensis.
vermontana [Huenella], Walcott [new]	Huenella vermontana.
verrucosa [Siphonotreta], Davidson [1853, Pl. IX, figs. 267 and 268]	Siphonotreta verrucosa.
Eichwald [1860, pp. 916–917]	Do.
Gagel [1890, p. 22]	Do.
Kutorga [1848, pp. 266–267]	Do.
Morris [1849, Pl. VII, figs. 2a–d]	Do.
Quenstedt [1871, p. 674]	Do.
Quenstedt [1885, p. 755]	Do.
Schmidt [1861, p. 218]	Do.
de Verneuil [1845, p. 287]	Do.
verrucosa [Terebratula], Eichwald [1840, pp. 140–141 (26–27)]	Do.
villaboimensis [Acrothele], Delgado [1904, p. 365]	Acrothele villaboimensis.
volborthi [Obolus], Mickwitz [1896, pp. 155–157]	Obolus volborthi.
Volborthia Hall and Clarke [1892a, p. 249]	Volborthia.
Hall and Clarke [1892b, p. 565]	Do.
Hall and Clarke [1892c, pp. 95–96]	Do.
von Möller [1874, pp. 449–452]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 143]	Do.
Volborthia recurva Hall and Clarke [1892a, figs. 261 and 262, p. 249]	Volborthia recurva.
Hall and Clarke [1892b, figs. 261 and 262, p. 565]	Do.
Hall and Clarke [1892c, pp. 95–96]	Do.
von Möller [1874, pp. 449–452]	Do.

W.

walcotti [Strophomena (Eostrophomena)], Moberg and Segerberg [1906, p. 71]	Eostrophomena elegantula.
wanneri [Yorkia], Walcott [1897b, p. 715]	Yorkia wanneri.
wanniecki [Lingulella], Redlich [1899, p. 7]	Lingulella wanniecki.
wanniecki [Obolus (Lingulella)], Walcott [1905a, p. 332]	Do.
wapta [Micromitra (Paterina)], Walcott [1908d, p. 59]	Micromitra (Paterina) wapta.
warthi [Lingula?], Waagen [1885a, pp. 769–770]	Lingulella kiurensis.
Waagen [1891, Pl. II, figs. 18a–h]	Do.
warthi [Neobolus], Frech [1897, Pl. IA, figs. 5a–b]	Neobolus warthi.
Hall and Clarke [1892a, p. 245]	Do.
Hall and Clarke [1892b, p. 561]	Do.
Hall and Clarke [1892c, p. 84]	Do.
Oehlert [1887, p. 1263]	Do
Waagen [1885a, pp. 758–759]	Do.
Waagen [1891, Pl. II, figs. 5–9]	Do.
warthi [Orthis], Waagen [1891, pp. 102–104]	Wynnia warthi.

	Present reference.
wasatchensis [Obolus (Westonia)], Walcott [1908d, pp. 69–70]	Obolus (Westonia) wasatchensis.
washingtonensis [Yorkia?], Walcott [1897b, pp. 715–716]	Yorkia? washingtonensis.
weeksi [Swantonia], Walcott [1905a, p. 297]	Swantonia weeksi.
welleri [Obolus (Lingulella)], Walcott [1902, p. 608]	Lingulella welleri.
(Westonia) Matthew [1903, pp. 205–206]	Obolus (Westonia).
(Westonia) [Obolus], Walcott [1901, pp. 683 and 691]	Do.
Walcott [1908e, Pl. XI, and pp. 142 and 144]	Do.
(Westonia) alandensis [Obolus], Walcott [1905a, p. 334]	Obolus (Westonia) ålandensis.
(Westonia) aurora [Obolus], Walcott [1901, p. 691]	Obolus (Westonia) aurora.
(Westonia) baltica [Obolus], Walcott [1905a, p. 334]	Obolus (Westonia) balticus.
(Westonia) blackwelderi [Obolus], Walcott [1905a, p. 335]	Obolus (Westonia) blackwelderi.
(Westonia) bottnica [Obolus], Walcott [1905a, pp. 335–336]	Obolus (Westonia) bottnicus.
(Westonia) chuarensis [Obolus], Walcott [1901, p. 691]	Obolus (Westonia) chuarensis.
(Westonia) dartoni [Obolus], Walcott [1908d, p. 67]	Obolus (Westonia) dartoni.
(Westonia) ella [Lingulella], Grabau and Shimer [1907, p. 193]	Obolus (Westonia) ella.
(Westonia) ella [Obolus], Walcott [1901, p. 691]	Do.
(Westonia) ella onaquiensis [Obolus], Walcott [1908d, pp. 67–68]	Obolus (Westonia) ella onaquiensis.
(Westonia) elongatus [Obolus], Walcott [1908d, p. 68]	Obolus (Westonia) elongatus.
Westonia escasoni Matthew [1903, pp. 206–209]	Obolus (Westonia) escasoni.
(Westonia) escasoni [Obolus], Walcott [1901, p. 691]	Do.
(Westonia) euglyphus [Obolus], Walcott [1901, p. 691]	Obolus (Westonia) euglyphus.
(Westonia) finlandensis [Obolus], Walcott [1902, pp. 611–612]	Obolus (Westonia) finlandensis.
(Westonia) iphis [Obolus], Walcott [1905a, p. 336]	Obolus (Westonia) iphis.
(Westonia?) lamellosus [Obolus], Walcott [1901, p. 691]	Obolus (Westonia?) lamellosus.
(Westonia) notchensis [Obolus], Walcott [1908d, p. 69]	Obolus (Westonia) notchensis.
(Westonia) rogersi [Obolus], Walcott [1901, p. 691]	Obolus (Westonia) rogersi.
(Westonia) stoneanus [Obolus], Walcott [1901, p. 691]	Obolus (Westonia) stoneanus.
(Westonia) themis [Obolus], Walcott [1905a, pp. 336–337]	Obolus (Westonia) themis.
(Westonia) wasatchensis [Obolus], Walcott [1908d, pp. 69–70]	Obolus (Westonia) wasatchensis.
(Westonia) wimani [Obolus], Walcott [1905a, p. 337]	Obolus (Westonia) wimani.
whiteavesi [Bicia], Walcott [1901, p. 680]	Bicia whiteavesi.
whitfieldi [Billingsella], Schuchert [1897, p. 159]	Billingsella whitfieldi.
Walcott [1905a, p. 246]	Do.
whitfieldi [Kutorgina], Walcott [1884b, pp. 18–19]	Do.
wichitaensis [Orthis (Plectorthis)], Walcott [1905a, pp. 271–272]	Eoorthis wichitaensis.
wichitaensis læviusculus [Orthis (Plectorthis)], Walcott [1905a, p. 272]	Eoorthis wichitaensis læviusculus.
williardi [Micromitra (Paterina)], Walcott [1908d, p. 60]	Micromitra (Paterina. williardi.
willisi [Obolus (Lingulella)], Walcott [1898b, pp. 418–419]	Obolus willisi.
Wimanella Walcott [1908d, pp. 98–99]	Wimanella.
Walcott [1908e, Pl. XI, and pp. 142 and 148]	Do.
Wimanella inyoensis Walcott [1908d, p. 99]	Wimanella inyoensis.
Wimanella shelbyensis Walcott [1908d, p. 100]	Wimanella shelbyensis.
Wimanella simplex Walcott [1908d, p. 101]	Wimanella simplex.
wimani [Obolus (Westonia)], Walcott [1905a, p. 337]	Obolus (Westonia) wimani.
wimani [Orthis (Plectorthis)], Moberg and Segerberg [1906, p. 70]	Eoorthis wimani.
Walcott [1905a, p. 272]	Do.
winfieldensis [Orthis (Plectorthis) remnicha], Walcott [1905a, p. 270]	Eoorthis remnicha winfieldensis.
wingi [Protorthis], Walcott [1905a, p. 286]	Protorthis wingi.
winona [Lingula], Hall [1863, p. 126]	Lingulella winona.
Hall [1867, p. 102]	Do.
Sardeson [1896, p. 96]	Do.
winona [Lingulella], Schuchert [1897, p. 258]	Do.
winona convexus [Obolus (Lingulella)], Walcott [1901, p. 691]	Lingulella winona convexa.
wirrialpensis [Obolella], Etheridge [1905, p. 248]	Obolella wirrialpensis.
wirrialpensis calceoloides [Obolella], Etheridge [1905, p. 249]	Do.
wirthi [Lingula], Barrande [1868a, p. 101]	Lingulella wirthi.
Barrande [1868b, p. 691]	Do.
woodworthi [Acrothele], Walcott [1908d, p. 88]	Acrothele woodworthi.
wortheni [Obolus], Walcott [1908d, pp. 63–64]	Obolus wortheni.
wynnei [Neobolus], Waagen [1885a, pp. 759–761]	Neobolus warthi.
Waagen [1891, Pl. II, figs. 10 and 11]	Do.
Wynnia Walcott [1908e, Pl. XI, and pp. 142 and 148]	Wynnia.

Y.

	Present reference.
yorkensis [Acrothele], Walcott [1908d, pp. 88–89]	Acrothele yorkensis.
Yorkia Walcott [1897b, p. 714]	Yorkia.
Walcott [1908e, Pl. XI, and pp. 142 and 146]	Do.
Yorkia miqueli Walcott [new]	Yorkia miqueli.
Yorkia? orientalis Walcott [1906, pp. 569–570]	Yorkia? orientalis.
Yorkia wanneri Walcott [1897b, p. 715]	Yorkia wanneri.
Yorkia? washingtonensis Walcott [1897b, pp. 715–716]	Yorkia? washingtonensis.

Z.

zeno [Eoorthis], Walcott [1908d, p. 106]	Eoorthis zeno.
zenobia [Micromitra], Walcott [new]	Micromitra zenobia.
zetus [Obolus (Lingulella)], Walcott [1898b, p. 419]	Obolus zetus.
zeus [Liugulella], Walcott [new]	Lingulella zeus.
zoppi [Obolus?], Walcott [1901, pp. 684–685]	Obolus? zoppi.

GEOLOGIC DATA.

GENERAL GEOGRAPHIC AND STRATIGRAPHIC DISTRIBUTION.

The distribution of the Brachiopoda, both Cambrian and Ordovician, is set forth in the four tables following. The first (pp. 98–109) gives the general geographic and stratigraphic distribution of the various Cambrian and Ordovician species, arranged zoologically; the second (pp. 110–112) gives a summary of the Cambrian Brachiopoda by genera and by families; the third (p. 113) a summary of the Ordovician Brachiopoda by genera and by families; and the fourth (p. 113) a general summary by families of all the Brachiopoda described in this paper, whether Cambrian or Ordovician.

The question of the systemic reference of some of the formations (e. g., whether the *Orthoceras* limestone and the *Ceratopyge* limestone should be placed in the Ordovician or the passage beds between the Upper Cambrian and Ordovician, or whether the *Ceratopyge* slate, the *Bryograptus* slate, and the *Dictyograptus* slate should be referred to the Upper Cambrian or the Ordovician, etc.) does not appear to be a vital one in connection with this monograph. Whenever possible, however, the localities included in these pages contain the names of the formations represented, and these should enable the student to refer the species to the desired place in the geologic column.

DISTRIBUTION BY SPECIES.

The following table gives the general geographic and stratigraphic distribution of the Cambrian and Ordovician Brachiopoda taken up in this monograph:

General geographic and stratigraphic distribution of the Cambrian and Ordovician Brachiopoda.

Name.	No.	Page.	Illustration.	Stratigraphic position.					Recurrent species and varieties.	Distinct species and varieties.	General geographic position.[a]
				Cambrian.			Passage beds.	Ordovician.			
				Lower.	Middle.	Upper.					
ATREMATA.											
Rustella edsoni	1	327	Pl. I	×							*Vermont* and Pennsylvania.
? major	2	328	Fig. 19	×							New Brunswick.
Total species				2						2	
Mickwitzia formosa	1	329	Pl. VI		×[b]						*Sweden* and Finland.
monilifera	2	330	VI, LIX	×	×[b]						*Sweden*, Finland, and Russia.
occidens	3	331	VI	×							California and *Nevada*.
pretiosa	4	332	VI	×							Sweden.
? sp. undt	5	332			×[b]						Sardinia.
Total species				3	3				1	5	

[a] Type locality in italic.
[b] The exact stratigraphic position of this species is not definitely known.

General geographic and stratigraphic distribution of the Cambrian and Ordovician Brachiopoda—Continued.

Name.	No.	Page.	Illustration.	Stratigraphic position.					Recurrent species and varieties.	Distinct species and varieties.	General geographic position.
				Cambrian.			Passage beds.	Ordovician.			
				Lower.	Middle.	Upper.					
ATREMATA—Cont'd.											
Micromitra alabamaensis.	1	337	Pl. II		×	×					*Alabama* and Tennessee.
haydeni	2	337	Fig. 20		×						Idaho.
nisus	3	338	Pl. II	×							Quebec.
pealei	4	339	III		×						*Montana*, Wyoming, and Arizona.
pusilla	5	339	III		×	×					Sweden, *Bornholm*, and England.
scotica	6	340	Fig. 21	×							Scotland.
sculptilis	7	341	Pl. III		×	×					*Montana*, Wyoming, Utah, and Nevada.
sculptilis endlichi	7a	342	Fig. 22			v					Nevada.
zenobia	8	342	23		×						British Columbia.
sp. undt	9	343	Pl. III		×						Wyoming.
Total species				2	7	3			3	9	
Total varieties						1				1	
Micromitra (Paterina):											
bella	1	344	Pl. II	×							*Quebec*, Newfoundland, Labrador, Massachusetts, Vermont, and Pennsylvania.
crenistria	2	345	III		×	×					*Arizona*, Nevada, Utah, and Tennessee.
etheridgei	3	346	III		× [a]						South Australia.
labradorica	4	347	II	×							Newfoundland, *Labrador*, New Brunswick, Quebec, New York, Nevada, British Columbia, and England.
labradorica orientalis.	4a	348	II		v						Shantung, China.
labradorica swantonensis.	4b	348	II	v	v						Vermont.
labradorica utahensis.	4c	349	Pl. II; Fig. 24		v						Utah.
labradorica var	4d	350		v							Nevada.
logani	5	350	Pl. II		× [a]						Quebec.
major	6	351	Fig. 25	×	×						Alabama.
phillipsi	7	351	Pl. III	×		×					England.
prospectensis	8	352	II	×							Nevada.
stissingensis	9	353	III		×						*New York*, Missouri (?), and British Columbia (?).
stissingensis ora	9a	354			v						British Columbia.
stuarti	10	354	Fig. 26		×						Utah.
superba	11	355	Pl. II; Fig. 27		×						*Arizona*, Utah, and Montana.
undosa	12	356	Fig. 28	×							Sweden.
wapta	13	357	29	×							*British Columbia* and Alberta.
williardi	14	358	Pl. II; Fig. 30	×							Alabama.
Total species				8	7	2			3	14	
Total varieties				2	4				1	5	
Micromitra (Iphidella):											
louise	1	359	Fig. 31	×							Alberta.
nyssa	2	360	Pl. III		×						Montana.
ornatella	3	360	III		×						*Sweden*, Norway, Bornholm, and Newfoundland.
pannula	4	361	Pl. IV; Fig. 32	×	×	×					British Columbia, Montana, Idaho, Utah, *Nevada*, Arizona, Georgia, Tennessee, New York, and Cape Breton.
pannula maladensis	4a	364	Pl. IV		v						*Idaho* and Newfoundland.
pannula ophirensis	4b	365	IV		v						*Utah*, Idaho, British Columbia, and Shantung, China (?).
Total species				2	3	1			2	4	
Total varieties					2					2	
Volborthia recurva	1	366	Pl. I; Fig. 33					×			Russia.
Helmersenia ladogensis.	1	368	Pl. LXIII			×					Do.
Curticia elegantula	1	369	I			×					Minnesota.
Obolus acadicus	1	380	XI			×					Cape Breton.
? advenus	2	380	XII					×			Bohemia.
anceps	3	380	X			×		×			Nevada.
? ancillus	4	381	XII					×			Bohemia.
apollinis	5	381	Pl. VII, XIV; Figs. 4 and 15		×	×					*Russia*, Finland, East and West Prussia, Sweden, and Poland.
apollinis ingricus	5a	384				v					Russia.
apollinis maximus	5b	384	Pl. VII, XIV			v					Do.
apollinis quenstedti	5c	384	Fig. 34			v					Do.

[a] The exact stratigraphic position of this species is not defin tely known.

General geographic and stratigraphic distribution of the Cambrian and Ordovician Brachiopoda—Continued.

Name.	No.	Page.	Illustration.	Stratigraphic position.					Recurrent species and varieties.	Distinct species and varieties.	General geographic position.
				Cambrian.			Passage beds.	Ordovician.			
				Lower.	Middle.	Upper.					
ATREMATA—Cont'd.											
Obolus—Continued.											
? bavaricus	6	385	Pl. XV				×				Bavaria.
belli	7	386	XXXVIII					×			Quebec.
chinensis	8	387	XXXIX		×						Shantung, China.
complexus	9	387	XII					×			Bohemia.
cyane	10	388	XXVII					×			Newfoundland.
discoideus	11	389	XVIII		×	×		×			Montana, Utah, Idaho, and *Nevada*.
dolatus	12	390	Fig. 35					×			Minnesota.
eichwaldi	13	390				×					Russia.
elegans	14	390	Pl. XV			×					Do.
feistmanteli	15	391	XII					×			Bohemia.
fragilis	16	392	XXIII		×						Newfoundland.
? inflatus	17	393					×				Sweden.
ismene	18	393	Pl. XI			×					Missouri.
lamborni	19	393	XXII		×	×					*Missouri*, Tennessee, Virginia, and Georgia.
lamborni minimus	19a	395	XXV		v						Tennessee.
loperi	20	395	IX				×				Colorado.
meeonnelli	21	396	XXIII		×						*British Columbia*, Alberta, Montana, Utah, Nevada, and California.
meeonnelli deciens.	21a	398	XXIII		v	v					*Nevada* and California.
meeonnelli pelias	21b	398	XXIII, XXXIX		v	v					Montana, *Utah*, and Nevada.
mæra	22	399	X		×	×	×				*Nevada*, Colorado, and Vermont (?).
matinalis	23	400	VIII		×	×		×			Montana, Wyoming, Idaho, Utah, Colorado, Texas, Oklahoma, Minnesota,[b] Wisconsin,[b] Virginia, Missouri (?), and Vermont (?).
matinalis?	24	402	VIII			×					Shantung, China.
membranaceus	25	402	Fig. 36		×						British Columbia.
menegbinii	26	403	Pl. XXX		×						Sardinia.
mickwitzi	27	403	X			×					Wisconsin.
minimus	28	404	XI		×						Shantung, China.
? minor	29	405	XV				×				Bavaria.
? mirandus	30	405	XII					×			Bohemia.
? murrayi	31	405	XV					×			Newfoundland.
namouna	32	406	VIII		×	×					*Wisconsin* and Minnesota.
nundina	33	406	XI		×	×					Nevada and *Texas*.
obscurus	34	406	XI		×						*Shantung* and Shansi, China.
? palliatus	35	407	XV				×				Bavaria.
pandemia	36	407	IX		×						Tennessee.
panderi	37	408				×					Russia.
parvus	38	408	Fig. 37	×							*British Columbia* and Alberta.
pheres	39	408	Pl. XI			×					Wisconsin.
prindlei	40	409	XXVII	×							*New York* and Vermont (?).
refulgens	41	409	IX			×					*New Brunswick* and Cape Breton.
rhea	42	410	IX		×	×					*Wisconsin* and Minnesota.
? rokitzanensis	43	411	XII					×			Bohemia.
rotundatus	44	411	XX		×	×		×			Montana, Utah, *Nevada*, Wyoming, and Georgia.
schmalenseei	45	412	XXX		×						*Sweden* and Denmark.
schmidti	46	412	XV			×					Russia.
selwyni	47	413	XXXVI, XXXVII		×						Cape Breton.
septalis	48	414	XXIII, XXXIV		×						British Columbia.
shansiensis	49	415	XI		×						*Shansi* and Shensi, China.
sinoe	50	415	XXVI		×	×					Wyoming, New Mexico, Missouri, Tennessee, Alabama, and *Texas*.
smithi	51	416	Fig. 38	×							Alabama.
tetonensis	52	417	Pl. IX		×	×					Montana, *Wyoming*, Arizona, and Utah.
tetonensis leda	52a	417				v					Utah.
tetonensis ninus	52b	418	Pl. VIII, XI			v					Idaho, *Oklahoma*, and Texas.
? torrentis	53	418			×						Cape Breton.
triangularis	54	419				×					*Russia* and Sweden.
volborthi	55	419				×					Russia.
willisi	56	420	Pl. XXIII		×	×					Alabama, *Georgia*, and Tennessee.
wortheni	57	421	Pl. IX Fig. 39		×	×					Idaho.
zetus	58	421	Pl. XXV		×	×					Arizona.
? zoppi	59	422	XXX		×						Sardinia.
sp. undt. a	60	422	X					×			New York.
sp. undt. b	61	422				× [a]					Nevada.
sp. undt. c	62	423						×			Do.
sp. undt. d	63	423				×					Vermont.
sp. undt. e	64	423	Pl. XV			×					Argentina.
? sp. undt. f	65	423	XV			×					China.
sp. undt. g	66	423			×						Sweden.
Total species				3	29	31	6	16	19	66	
Total varieties					3	7			2	8	

[a] The exact stratigraphic position of this species is not definitely known.
[b] See footnote on p. 401.

General geographic and stratigraphic distribution of the Cambrian and Ordovician Brachiopoda—Continued.

Name.	No.	Page.	Illustration.	Stratigraphic position.					Recurrent species and varieties.	Distinct species and varieties.	General geographic position.
				Cambrian.			Passage beds.	Ordovician.			
				Lower.	Middle.	Upper.					
ATREMATA—Cont'd.											
Obolus (Bröggeria):											
salteri	1	424	Pl. XIII, XV	.....	.....	×	×	.....	.....	.....	Norway, Sweden, *England*, and Cape Breton.
Obolus (Palæobolus):											
bretonensis	1	426	XXXII	.....	×	.....	.....	.....	.....	.....	Cape Breton.
bretonensis lens	1a	427		.....	v	.....	.....	.....	.....	.....	Do.
Total species	.....	.....	.....	.....	1	.....	.....	.....	.....	1	
Total varieties	.....	.....	.....	.....	1	.....	.....	.....	.....	1	
Obolus (Fordinia):											
bellulus	1	428	Pl. LI	.....	.....	×	.....	.....	.....	.....	*Nevada* and Utah (?).
gilberti	2	429	LI	.....	×	.....	.....	.....	.....	.....	Utah.
perfectus	3	429	LXIII	.....	×	.....	.....	.....	.....	.....	Do.
Total species	.....	.....	.....	.....	2	1	.....	.....	.....	3	
Obolus (Lingulobolus):											
affinis	1	431	Pl. XVI	.....	.....	.....	.....	×	.....	.....	*Newfoundland* and Massachusetts.
spissus	2	432	XVI, XLII	.....	.....	.....	.....	×	.....	.....	Do.
Total species	.....	.....	.....	.....	.....	.....	.....	2	.....	2	
Obolus (Mickwitzella):											
siluricus	1	434	Pl. XV	.....	.....	.....	×	.....	.....	.....	*Russia* and Poland.
Obolus (Acritis):											
antiquissimus	1	437	XIII, XV	.....	.....	.....	×	.....	.....	.....	*Russia* and Germany.
?rugatus	2	441	XIII	.....	×	.....	.....	.....	.....	.....	Nevada.
Total species	.....	.....	.....	.....	1	.....	1	.....	.....	2	
Obolus (Schmidtia):											
acuminatus	1	442	Pl. XIV	.....	.....	×	.....	.....	.....	.....	Russia.
celatus	2	444	XIV	.....	.....	×	.....	.....	.....	.....	*Russia* and Sweden.
crassus	3	446	XIV	.....	.....	×	.....	.....	.....	.....	Russia.
obtusus	4	448	XIV	.....	.....	×	.....	.....	.....	.....	*Russia* and Sweden.
Total species	.....	.....	.....	.....	.....	4	.....	.....	.....	4	
Obolus (Westonia):											
ålandensis	1	451	Pl. XLVIII	.....	×[a]	.....	.....	.....	.....	.....	Sweden and *Finland* (North Baltic region).
aurora	2	451	XLVI	.....	.....	×	.....	.....	.....	.....	*Wisconsin* and Minnesota.
balticus	3	453	XLVIII	.....	×[a]	.....	.....	.....	.....	.....	*Sweden* and Finland (North Baltic region).
blackwelderi	4	453	XXXIX	.....	×	.....	.....	.....	.....	.....	Shantung, China.
bottnicus	5	454	XLVIII	.....	×[a]	.....	.....	.....	.....	.....	*Sweden* and Finland (?) (North Baltic region).
chuarensis	6	454	XXV	.....	×	.....	.....	.....	.....	.....	Arizona.
dartoni	7	455	Fig. 40	.....	×	.....	.....	.....	.....	.....	Wyoming.
ella	8	455	Pl. XXXIII, XLVII	×	×	×	.....	.....	.....	.....	British Columbia, Montana, Idaho, Wyoming, *Utah*, Colorado, Nevada, Tennessee, and Alabama.
ella onaquiensis	8a	459	XLIX	.....	v	.....	.....	.....	.....	.....	Utah.
elongatus	9	459	LXIII	.....	.....	.....	.....	×	.....	.....	Do.
escasoni	10	459	XLIX	.....	×[a]	×	.....	.....	.....	.....	Cape Breton.
euglyphus	11	461	XLVIII	.....	×	.....	.....	.....	.....	.....	Arizona.
finlandensis	12	462	XLVIII	.....	×	.....	.....	.....	.....	.....	Finland.
iphis	13	462	XLIX	.....	.....	×	.....	×	.....	.....	*Nevada* and Utah.
?lamellosus	14	463	XII	.....	.....	.....	.....	×	.....	.....	Bohemia.
notchensis	15	463	LXIII	.....	.....	.....	.....	×	.....	.....	Utah.
rogersi	16	463	XLII	.....	.....	.....	.....	×	.....	.....	Massachusetts, *Rhode Island*, and Newfoundland.
stoneanus	17	465	XXVIII, XLIX	.....	.....	×	.....	.....	.....	.....	*Wisconsin*, New Jersey, and New Mexico.
themis	18	466	XI	.....	×	.....	.....	.....	.....	.....	Arizona.
wasatchensis	19	466	Pl. XLIX; Fig. 41	.....	×	.....	.....	.....	.....	.....	*Utah* and Idaho.
wimani	20	467	Pl. XLVIII	.....	×[a]	.....	.....	.....	.....	.....	*Sweden* and Finland.
sp. undt. a	21	468	.....	.....	.....	×	.....	.....	.....	.....	Shantung, China.
sp. undt. b	22	468	.....	.....	.....	.....	×	.....	.....	.....	Nevada.
Total species	.....	.....	.....	1	13	6	1	5	4	22	
Total varieties	.....	.....	.....	.....	1	.....	.....	.....	.....	1	
Lingulella acutangula	1	474	Pl. XVII	.....	×	×	.....	.....	.....	.....	Missouri, *Texas*, Arizona, New Mexico (?), and Nevada (?).
agnostorum	2	476	XXX	.....	×[b]	.....	.....	.....	.....	.....	Sweden.
ampla	3	477	XXVIII	.....	×	×	.....	.....	.....	.....	*Minnesota*, Wisconsin, and South Dakota (?).
arguta	4	478	XXIV	.....	×	×	.....	.....	.....	.....	Utah and *Nevada*.
atava	5	479	XXXV	.....	×	.....	.....	.....	.....	.....	Cape Breton.
atava insulæ	5a	480	XXXV	.....	v	.....	.....	.....	.....	.....	Do.
auga	6	480	XXIV	.....	×	.....	.....	.....	.....	.....	Tennessee.

[a] The exact stratigraphic position of this species is not definitely known.
[b] This species occurs in passage beds between the Middle and Upper Cambrian, but is entered as Middle Cambrian in the tables.

General geographic and stratigraphic distribution of the Cambrian and Ordovician Brachiopoda—Continued.

Name.	No.	Page.	Illustration.	Stratigraphic position.					Recurrent species and varieties.	Distinct species and varieties.	General geographic position.
				Cambrian.			Passage beds.	Ordovician.			
				Lower.	Middle.	Upper.					
ATREMATA—Cont'd.											
Lingulella—Continued.											
bella	7	481	Pl. XIX, XXXVI	.....	.....	×	.....	×	.....	.....	*Newfoundland* and Rhode Island.
bellula	8	482	XIX	.....	.....	×	.....	.....	.....	.....	Newfoundland.
billingsiana	9	483	XXIX	.....	.....	×	.....	.....	.....	.....	Do.
bornemanni	10	483	XXX	.....	×[a]	.....	.....	.....	.....	.....	Sardinia.
buttsi	11	484	XXIX	.....	×	.....	.....	.....	.....	.....	Alabama.
cania	12	484	XXXV	.....	×	.....	.....	.....	.....	.....	Cape Breton.
cedens	13	485	XXX	.....	.....	.....	×	.....	.....	.....	Bavaria.
clarkei	14	485	Fig. 42	.....	×	.....	.....	.....	.....	.....	Nevada.
collicia	15	486	Pl. XXXV	.....	×	.....	.....	.....	.....	.....	Cape Breton.
concinna	16	486	XXXIII, XXXIV	.....	×	×	.....	.....	.....	.....	*Cape Breton* and Sweden (?).
cuneola	17	488	XXVII	.....	×	.....	.....	.....	.....	.....	South Dakota.
damesi	18	489	XXXIX	.....	×	×?	.....	.....	.....	.....	Shantung, China.
davidsoni	19	489	XXXII	.....	.....	.....	.....	×	.....	.....	Bohemia.
davisi	20	489	XXX, XXXI	.....	.....	×	.....	×	.....	.....	*North Wales*, South Wales, England, Cape Breton, Argentina, and China.
delgadoi	21	491	XXIX	×	.....	.....	.....	.....	.....	.....	Portugal.
desiderata	22	492	XX	.....	×	×	.....	×	.....	.....	Colorado, *Wyoming*, Montana, Idaho, Utah, Nevada, Alabama, Georgia, Tennessee, Missouri, South Dakota, and British Columbia.
dubia	23	494	XXIV	.....	×	.....	.....	.....	.....	.....	Nevada.
ellsi	24	495	XIX	.....	.....	.....	.....	×	.....	.....	Quebec.
ferruginea	25	496	XXIX, XXX, XXXI, XXXV.	.....	×	×	.....	.....	.....	.....	*Wales*, Sweden, Denmark, Norway, Newfoundland, Nova Scotia, New Brunswick, and Argentina.
cf. ferruginea	26	500	XXX	.....	×	.....	.....	.....	.....	.....	Bohemia.
flumenis	27	500	XXXV	.....	×	.....	.....	.....	.....	.....	Cape Breton.
franklinensis	28	501	XXVI	.....	×[a]	.....	.....	.....	.....	.....	Vermont.
fuchsi	29	502	XXXIX	.....	×	.....	.....	.....	.....	.....	India.
grandis	30	502	XXXVIII	.....	.....	.....	.....	×	.....	.....	New Brunswick.
granvillensis	31	504	XXII	×	.....	.....	.....	.....	.....	.....	*New York* and Vermont.
hayesi	32	505	XXV	.....	×	.....	.....	.....	.....	.....	Alabama.
heberti	33	505	XXXIX	.....	.....	.....	.....	×	.....	.....	Spain.
helena	34	506	XXIV	.....	×	.....	.....	.....	.....	.....	*Montana*, Wyoming, Idaho, and Utah.
? humillima	35	507	XXX	.....	.....	.....	×	.....	.....	.....	Bavaria.
ino	36	507	XXVI	.....	×	.....	.....	.....	.....	.....	Tennessee and *Georgia*.
? insons	37	508	XXXII	.....	.....	.....	.....	×	.....	.....	Bohemia.
iole	38	508	XXVII	.....	.....	.....	.....	×	.....	.....	Newfoundland.
irene	39	508	XXVII	.....	.....	.....	.....	×	.....	.....	Quebec.
iris	40	509	XXVII	.....	.....	×	.....	.....	.....	.....	Do.
isse	41	509	Pl. XXXIX; Fig. 43	.....	×	×	.....	.....	.....	.....	*Utah*, Nevada, Idaho, and British Columbia.
kiurensis	42	511	Pl. XXX	.....	×	.....	.....	.....	.....	.....	India.
lævis	43	512	XIX	.....	.....	×	.....	.....	.....	.....	New Brunswick.
lævis grandis	43a	512	XIX	.....	.....	v	.....	.....	.....	.....	New Brunswick and *Cape Breton*.
lens	44	512	XXXIII	.....	.....	×	.....	.....	.....	.....	Cape Breton.
leos	45	513	XXIV	.....	.....	×	.....	.....	.....	.....	Georgia.
lepis	46	514	XXXI	.....	.....	×	×	.....	.....	.....	Norway, Sweden, *Wales*, Nova Scotia, and New Brunswick.
lineolata	47	515	XLVIII	.....	×	.....	.....	.....	.....	.....	Arizona.
linnarssoni	48	516	XXX	.....	×	.....	.....	.....	.....	.....	Sweden.
manticula	49	517	XX	.....	×	×	.....	×	.....	.....	*Nevada*, Utah, and Idaho (?).
martinensis	50	518	XXXVIII	.....	×	.....	.....	.....	.....	.....	New Brunswick.
minor	51	519	XXXVII	.....	.....	×	.....	.....	.....	.....	*New Brunswick* and Cape Breton.
mosia	52	520	XVIII	.....	.....	×	.....	×	.....	.....	Minnesota, *Wisconsin*, and Iowa.
mosia osceola	52a	521	XVIII	.....	.....	v	.....	.....	.....	.....	Wisconsin.
nanno	53	521	XXIV	.....	×	.....	.....	.....	.....	.....	Alabama.
nathorsti	54	521	XXXI	×	.....	.....	.....	.....	.....	.....	Sweden.
nicholsoni	55	522	XXX	.....	.....	×	.....	.....	.....	.....	England.
ora	56	522	XXXV	.....	×?	×	.....	.....	.....	.....	*Oklahoma* and Missouri (?).
oweni	57	523	XVIII	.....	.....	×	.....	.....	.....	.....	*Wisconsin* and Minnesota.
perattenuata	58	523	XXI	.....	×	×	.....	.....	.....	.....	*South Dakota*, Texas, and Arizona.
phaon	59	525	XXVI	.....	.....	×	.....	.....	.....	.....	Minnesota and *Wisconsin*.
pogonipensis	60	525	XX	.....	.....	×?	×	.....	.....	.....	*Nevada*, Utah(?), and Arizona(?).
prima	61	526	XXVII	.....	.....	×	.....	.....	.....	.....	New York.
? primæva	62	527	XXXI	.....	×[a]	.....	.....	.....	.....	.....	South Wales.
punctata	63	528	XX	.....	×	×	.....	.....	.....	.....	Nevada.
quadrilateralis	64	528	XXXIX	.....	×	.....	.....	.....	.....	.....	*Alabama* and Georgia.
radula	65	529	XLV	.....	×	.....	.....	.....	.....	.....	*New Brunswick* and Cape Breton.
randomensis	66	530	XXI	.....	.....	×	.....	.....	.....	.....	Newfoundland.
rotunda	67	530	XXXVII	.....	×	.....	.....	.....	.....	.....	Cape Breton.
schucherti	68	530	XXI	×	.....	.....	.....	.....	.....	.....	New York.
siemiradzkii	69	531	XXXI	.....	×	.....	.....	.....	.....	.....	Poland.
signata	70	532	XXX	.....	.....	.....	×	.....	.....	.....	Bavaria.

[a] The exact stratigraphic position of this species is not definitely known.

General geographic and stratigraphic distribution of the Cambrian and Ordovician Brachiopoda—Continued.

Name.	No.	Page.	Illustration.	Stratigraphic position.					Recurrent species and varieties.	Distinct species and varieties.	General geographic position.
				Cambrian.			Passage beds.	Ordovician.			
				Lower.	Middle.	Upper.					
ATREMATA—Cont'd.											
Lingulella—Continued.											
similis	71	532	Pl. XXI	.....	×	×	.....	.....	.....	.....	Minnesota, Wisconsin, Tennessee, Alabama, Missouri, Oklahoma, *South Dakota*, Colorado, Utah (?), Georgia, and Nevada.
? simplex	72	534	XXXII	.....	.....	.....	.....	×	.....	.....	Bohemia.
tarpa	73	534	XXIII	.....	×	.....	.....	.....	.....	.....	Tennessee.
texana	74	535	XLIX	.....	.....	×	.....	.....	.....	.....	Missouri and *Texas*.
torrentis	75	535	XXXV	.....	×	.....	.....	.....	.....	.....	Cape Breton.
triparilis	76	536	Pl. XLV, Fig. 44	.....	×	.....	.....	.....	.....	.....	Do.
tumida	77	537	Pl. XXIV	.....	×	.....	.....	.....	.....	.....	Do.
upis	78	538	XXXVI	.....	.....	×	.....	.....	.....	.....	Texas.
wanniecki	79	538	XXXIX	.....	×	.....	.....	.....	.....	.....	India.
welleri	80	539	XXXVIII	.....	.....	×	.....	.....	.....	.....	New Jersey.
winona	81	539	XVIII	.....	.....	×	.....	.....	.....	.....	*Iowa*, Minnesota, and Wisconsin.
winona convexa	81a	540	XVIII	.....	.....	v	.....	.....	.....	.....	*Wisconsin* and Arizona.
wirthi	82	541	XXX	.....	.....	.....	×	.....	.....	.....	Bavaria.
zeus	83	541	Fig. 45	×	.....	.....	.....	.....	.....	.....	Scotland.
sp. undt. a	84	541	Pl. XXX	.....	.....	×	.....	.....	.....	.....	Sweden.
sp. undt. b	85	541	.....	.....	×	.....	.....	.....	.....	.....	Pennsylvania.
Total species	.....	.....	.....	5	46	35	6	13	20	85	
Total varieties	.....	.....	.....	.....	1	3	.....	.....	.....	4	
Lingulella (Leptembolon):											
lingulæformis	1	542	Pl. XIV	.....	.....	×	×	.....	.....	.....	Esthonia, Russia.
Lingulella (Lingulepis):											
acuminata	1	545	XXXIV, XL, XLI, XLII.	.....	×	×	.....	×	.....	.....	Ontario, Quebec, *New York*, Virginia, Alabama, Tennessee, Oklaboma, Texas, Nevada, Utah, Colorado, Wyoming, South Dakota, Minnesota, Vermont, Wisconsin, and Michigan.
acuminata meeki	1a	550	XLI	.....	v	.....	.....	.....	.....	.....	*Wyoming* and Montana.
acuminata sequens	1b	551	Fig. 46	.....	.....	.....	.....	v	.....	.....	New York.
eros	2	551	Pl. XXXIX	.....	×	.....	.....	.....	.....	.....	Shantung, China.
exigua	3	551	XXXIII, XLIII	.....	×	×	.....	.....	.....	.....	Cape Breton.
gregwa	4	554	XLIV	.....	×	.....	.....	.....	.....	.....	Do.
gregwa robusta	4a	555	.....	.....	v	.....	.....	.....	.....	.....	Do.
longinervis	5	555	Pl. XLIV	.....	×	.....	.....	.....	.....	.....	Do.
pumila	6	556	XLV	.....	×	.....	.....	.....	.....	.....	Do.
? pygmæa	7	556	XXX	.....	.....	×	.....	.....	.....	.....	England.
roberti	8	557	XXXVII	.....	×	.....	.....	.....	.....	.....	Cape Breton.
rowei	9	558	XXI	×	.....	.....	.....	.....	.....	.....	California.
spatula	10	558	XIX	.....	×	.....	.....	.....	.....	.....	Arizona.
? squamosa	11	559	XXX	.....	.....	×	.....	.....	.....	.....	England.
starri	12	559	XXXVII	.....	.....	×	.....	.....	.....	.....	New Brunswick.
? sp. undt	13	560	.....	.....	×	.....	.....	.....	.....	.....	Shansi, China.
Total species	.....	.....	.....	1	9	5	.....	1	3	13	
Total varieties	.....	.....	.....	.....	2	.....	.....	1	.....	3	
Delgadella lusitanica	1	560	Pl. XXIX	×	.....	.....	.....	.....	.....	.....	Portugal.
Elkania ambigua	1	562	LI	.....	.....	.....	.....	×	.....	.....	Nevada.
desiderata	2	562	LI	.....	.....	.....	.....	×	.....	.....	Quebec.
ida	3	563	XXX, LI	.....	.....	.....	.....	×	.....	.....	Do.
Total species	.....	.....	.....	.....	.....	.....	.....	3	.....	3	
Neobolus warthi	1	566	Pl. I, LXXXI, Fig. 47	.....	×	.....	.....	.....	.....	.....	India.
Bicia gemma	1	569	Pl. L	×	.....	.....	.....	.....	.....	.....	Quebec, *Labrador*, and New York.
whiteavesi	2	570	L	×	.....	.....	.....	.....	.....	.....	New York.
Total species	.....	.....	.....	2	.....	.....	.....	.....	.....	2	
Dicellomus appalachia	1	572	Pl. LIII	.....	×	.....	.....	.....	.....	.....	Tennessee, *Alabama*, and Virginia.
nanus	2	573	LIII	.....	×	×	.....	×	.....	.....	Montana, Wyoming, *South Dakota*, and Missouri.
parvus	3	574	LXXXIX	.....	×	.....	.....	.....	.....	.....	*Shantung* and Shensi, China.
pectenoides	4	575	Pl. LII, Fig. 48	.....	×	×	.....	.....	.....	.....	Montana, *South Dakota*, and Wisconsin.
politus	5	575	Pl. LII, Figs. 16 and 49	.....	×	×	.....	.....	.....	.....	Montana, Utah, Arizona, South Dakota, Oklahoma, Tennessee, Wisconsin, Missouri, and *Minnesota*.
prolificus	6	578	Pl. LXXXIX	.....	×	.....	.....	.....	.....	.....	Utah.
sp. undt	7	578	LII	.....	×	.....	.....	.....	.....	.....	Sweden.
Total species	.....	.....	.....	.....	7	3	.....	1	4	7	

General geographic and stratigraphic distribution of the Cambrian and Ordovician Brachiopoda—Continued.

Name.	No.	Page.	Illustration.	Stratigraphic position.					Recurrent species and varieties.	Distinct species and varieties.	General geographic position.
				Cambrian.			Passage beds.	Ordovician.			
				Lower.	Middle.	Upper.					
ATREMATA—Cont'd.											
Kutorgina cingulata	1	580	Pl. V, Figs. 3, 8, and 50	×							*Labrador*, Quebec, Vermont, Nevada, British Columbia, and Siberia.
granulata	2	582	Pl. V	×							Newfoundland.
peculiaris	3	583	V		×[a]						South Australia.
perugata	4	583	V	×							*Nevada* and California.
sardiniaensis	5	584	V		×[a]						Sardinia.
sp. undt	6	584		×							Virginia.
Total species				4	2					6	
Schuchertina cambria	1	585	Pl. LI		×						Montana.
NEOTREMATA.											
Obolella asiatica	1	588	LV	×							Shantung and *Shensi*, China.
atlantica	2	589	Pl. LV, Fig. 51	×							*Newfoundland*, Massachusetts, and Georgia.
chromatica	3	591	Pl. LIV	×							*Labrador*, Newfoundland, and New York.
crassa	4	592	Pl. LIV, Fig. 14	×							Labrador, Quebec, Vermont, *New York*, Pennsylvania (?), Georgia (?), and Massachusetts.
crassa elongata	4a	595	Pl. LV	v							Quebec.
groomi	5	595	Fig. 52	×							England.
? lindströmi	6	596	Pl. LV	×							Sweden.
minor	7	596	LIV	×							Maryland, *New York*, Pennsylvania, Virginia, and West Virginia.
mobergi	8	597	LV	×							*Sweden* and Norway.
vermilionensis	9	598	Fig. 53	×							California and *Alberta*.
wirrialpensis	10	599	Pl. LV	×[a]							South Australia.
sp. undt	11	599		×							Portugal.
Total species				11						11	
Total varieties				1						1	
Obolella (Glyptias): favosa	1	600	Pl. LV	×							*Sweden* and Norway.
Botsfordia? barrandei	1	602	LVII		×						Spain.
cælata	2	603	LIX	×	×						New Brunswick, Quebec, Vermont, Labrador, and *New York*.
granulata	3	605	LVII		×						India.
pulchra	4	607	LXII		×						New Brunswick.
Total species				1	4				1	4	
Schizopholis rugosa	1	609	Pl. I, LXXXI		×						India.
Quebecia circe	1	610	CIV	×							*Quebec* and Labrador.
Yorkia? miqueli	1	611	LXXXII				×				France.
? orientalis	2	612	LXXXII		×						Shansi, China.
wanneri	3	612	LXXXII	×							Quebec (?), *Pennsylvania*, and California (?).
? washingtonensis	4	613	LXXXII	×							New York.
Total species				2	1		1			4	
Dearbornia clarki	1	614	Pl. LXXXII		×						Montana.
Trematoholus excelsis	1	617	LXXXII	×							California.
insignis	2	617	LXXXIV		×						New Brunswick.
kempanum	3	619	LXXXIII		×						Do.
pristinus	4	621	LXXXIII, LXXXIV		×						Do.
Total species				1	3					4	
Schizambon? esthonia	1	622	Pl. LXXXIV			×					Russia.
manitouensis	2	623	LXXXIV					×			Colorado.
priscus	3	623	LXXXIV			×					*Cape Breton* and New Brunswick.
typicalis	4	624	LXXXIV			×		×			*Nevada* and Utah.
Total species						3		2	1	4	
Siphonotreta? duhia	1	625	Pl. LXXXI	×							Nevada.
unguiculata	2	626	LXXXI				×	×			*Russia* and East and West Prussia.
verrucosa	3	627	LXXXI				×	×			Do.
Total species				1			2	2	2	3	

[a] The exact stratigraphic position of this species is not definitely known.

General geographic and stratigraphic distribution of the Cambrian and Ordovician Brachiopoda—Continued.

Name.	No.	Page.	Illustration.	Stratigraphic position.					Recurrent species and varieties.	Distinct species and varieties.	General geographic position.
				Cambrian.			Passage beds.	Ordovician.			
				Lower.	Middle.	Upper.					
NEOTREMATA—Continued.											
Keyserlingia buchi	1	628	Pl. LXXXI			×					Russia.
Acrothele artemis	1	634	Fig. 54		×						Idaho.
avia	2	634	Pl. LXI, LXII		×						Cape Breton.
avia puteis	2a	636			v						Do.
bellapunctata	3	636	Pl. LVII	×							Norway.
bellula	4	637	LVIII		×						Alabama.
bergeroni	5	638	LVIII		×						France.
bohemica	6	639	LVII		×						Bohemia.
borgholmensis	7	639	LXIII			×					Sweden.
ceratopygarum	8	640	LXIII				×				*Norway* and Sweden.
colleni	9	640	Pl. LXIII; Fig. 55	×	×						British Columbia, Alberta, and *Montana*.
coriacea	10	642	Pl. LVI		×[a]		×				Norway, *Sweden*, and Denmark.
decipiens	11	644	LVIII	×							Pennsylvania.
dichotoma	12	644	LX		×						Nevada.
gamagei	13	645	LX		×						Massachusetts.
intermedia	14	646	LVI		×	×?					*Sweden*, Denmark, and England (?).
levisensis	15	646	LXXXI					×			Quebec.
maculata	16	647	LVII, LVIII		×						Wales.
matthewi	17	647	LXI		×	×					Newfoundland and *New Brunswick*.
matthewi eryx	17a	649	LXI		v						Shantung, China.
matthewi lata	17b	649	LXI		v						New Brunswick.
matthewi multicostata	17c	650	LXI		v						Do.
? minuta	18	650	LXIII		×						Shantung, China.
nitida	19	650	LVIII	×							New York.
panderi	20	651	LIX	×							Montana.
pretiosa	21	652	LVIII					×			*Quebec* and New York.
prima	22	653	LXI, LXII		×						*New Brunswick* and Cape Breton.
prima costata	22a	653	LXI		v						*New Brunswick* and Newfoundland.
primæva	23	654	LVII		×						Spain.
proles	24	654	LXII		×						Cape Breton.
quadrilineata	25	655	LVII		×						Bohemia.
rara	26	655	LXIII		×						Shantung, China.
spurri	27	656	LX	×							Nevada.
subsidua	28	656	LX		×						*Utah*, Idaho, and British Columbia.
subsidua hera	28a	659	LX	v							Nevada.
subsidua lævis	28b	659			v						Utah.
turneri	29	660	Pl. LX		×						*Nevada* and Utah (?).
villaboimensis	30	660		×							Portugal.
woodworthi	31	661	Pl. LX	×							Massachusetts.
yorkensis	32	661	LIX		×						Pennsylvania.
sp. undt. a	33	662	LXIII	×							Quebec.
sp. undt. Moberg	34	662		×							Sweden.
Total species				10	21	3	2	2	4	34	
Total varieties				1	6					7	
Acrothele(Redlichella): granulata	1	663	Pl. LVI		×						Sweden.
Discinolepis granulata	1	664	LXXXI		×						India.
Linnarssonella girtyi	1	666	LXXVIII; LXXIX		×	×					Utah, *South Dakota*, Oklahoma, Texas, Nevada, and Missouri.
minuta	2	667	LXXIX			×		×			Nevada.
modesta	3	668	LXXVIII			×					Utah.
nitens	4	669	LXXVIII			×					Do.
tennesseensis	5	669	LXXIX		×	×					*Tennessee* and Utah.
transversa	6	670	LXXVIII			×					Utah.
urania	7	670	LXXVIII		×						Do.
Total species					3	6		1	3	7	
Acrotreta argenta	1	674	Pl. LXVII			×					Nevada.
attennata	2	675	LXIV, LXXIX		×	×					Nevada, Utah, Wyoming, and *Montana*.
attenuata var	2a	676	LXV		v						Montana.
babel	3	676	LXXVII					×			Bohemia.
baileyi	4	676	LXXVII		×						New Brunswick.
bellatula	5	677	LXXVIII		×						Utah.
belti	6	678	LXXVII			×					*North Wales* and England.
bisecta	7	678	LXVI			×					*Cape Breton* and New Brunswick.
?? cancellata	8	679	LXXIX				×				Nevada.
carinata	9	679	Fig. 56				×				Sweden.
circularis	10	680	Fig. 57				×				Do.
claytoni	11	680	Pl. LXXIV	×							Nevada.
concentrica	12	681	LXXVII		×						Georgia.

[a] This species also occurs in passage beds between the Middle and Upper Cambrian.

General geographic and stratigraphic distribution of the Cambrian and Ordovician Brachiopoda—Continued.

Name.	No.	Page.	Illustration.	Stratigraphic position.					Recurrent species and varieties.	Distinct species and varieties.	General geographic position.
				Cambrian.			Passage beds.	Ordovician.			
				Lower.	Middle.	Upper.					
NEOTREMATA—Continued.											
Acrotreta—Continued.											
conula	13	681	Pl. LXXV	.....	.....	×	.....	.....	.....	.....	Sweden.
convexa	14	682	LXVI	.....	.....	×	.....	.....	.....	.....	Cape Breton.
curvata	15	682	LXVIII	.....	.....	×	×	.....	.....	.....	*Nevada* and Oklahoma.
definita	16	683	LXIV	.....	×	.....	.....	.....	.....	.....	Nevada, *Idaho*, and Wyoming.
depressa	17	683	LXVI	.....	×	.....	.....	.....	.....	.....	British Columbia.
eggegrundensis	18	684	LXX	.....	×[a]	.....	.....	.....	.....	.....	*Sweden* and Finland.
emmonsi	19	684	LXV	×	.....	.....	.....	.....	.....	.....	New York.
gemma	20	685	LXVI	.....	.....	.....	.....	×	.....	.....	Newfoundland.
gemmula	21	686	LXVI, LXXVII	.....	×	.....	.....	.....	.....	.....	*New Brunswick* and Cape Breton.
gracia	22	687	LXVI	.....	×	.....	.....	.....	.....	.....	New Brunswick.
idahoensis	23	687	LXV, LXVIII	.....	×	×	.....	×	.....	.....	Nevada, Utah, *Idaho*, Wyoming, Montana, and South Dakota.
idahoensis alta	23a	689	LXV	.....	v	v	v	v	.....	.....	*Nevada*, Utah, and Montana.
idahoensis sulcata	23b	690	LXV	.....	v	v	.....	.....	.....	.....	Utah and *Idaho*.
cf. idahoensis	24	688	.....	.....	×	.....	.....	.....	.....	.....	Nevada.
inchoans	25	690	Pl. XV	.....	.....	.....	×	.....	.....	.....	Bavaria.
inflata	26	690	LXXVI	.....	×	.....	.....	.....	.....	.....	New Brunswick.
kutorgai	27	692	Pl. LXV Fig. 58	.....	×	×	.....	.....	.....	.....	*Alabama* and Tennessee.
lisani	28	692	Pl. LXVIII	.....	×	.....	.....	.....	.....	.....	Shantung, China.
marjumensis	29	693	LXXVIII	.....	×	×	.....	.....	.....	.....	Utah.
microscopica	30	693	LXVII	.....	×	×	.....	.....	.....	.....	Nevada, *Texas*, and Oklahoma.
microscopica missouriensis.	30a	694	LXVII	.....	v	.....	.....	.....	.....	.....	Missouri.
microscopica tetonensis.	30b	694	LXVII	.....	v	.....	.....	.....	.....	.....	Wyoming.
? minima	31	695	LXXVII	.....	.....	.....	.....	×	.....	.....	Bohemia.
misera	32	695	LXXII	.....	×	.....	.....	.....	.....	.....	*Newfoundland* and New Brunswick.
neboensis	33	695	LXXVII	.....	×	.....	.....	.....	.....	.....	Utah.
nicholsoni	34	696	LXXIII	.....	.....	×	.....	×	.....	.....	*Scotland*, Ireland, and England.
nox	35	696	LXXVII	.....	.....	×	.....	.....	.....	.....	Wisconsin.
œlandica	36	697	.....	.....	.....	×	.....	.....	.....	.....	Sweden.
ophirensis	37	697	Pl. LXXIV	.....	×	.....	.....	.....	.....	.....	Utah.
ophirensis descendens.	37a	698	LXXVIII	.....	v	.....	.....	.....	.....	.....	Do.
ophirensis rugosa	37b	699	LXXIV	.....	v	.....	.....	.....	.....	.....	Do.
cf. ophirensis	38	698	.....	.....	×	.....	.....	.....	.....	.....	Do.
ovalis	39	699	Pl. LXVI	.....	.....	.....	.....	×	.....	.....	Quebec.
pacifica	40	699	LXIX	.....	×	.....	.....	.....	.....	.....	Shantung, China.
parvula	41	699	LXXVII	.....	×[b]	.....	.....	.....	.....	.....	Sweden.
primæva	42	700	LXIX	×	×	.....	.....	.....	.....	.....	Nevada.
pyxidicula	43	701	LXIX	.....	×	×	.....	.....	.....	.....	*Nevada*, Utah, Idaho, and Montana.
rudis	44	702	LXV, LXXV	.....	×	.....	.....	.....	.....	.....	Tennessee.
sabrinæ	45	702	LXXIII	.....	.....	×	.....	.....	.....	.....	England.
sagittalis	46	704	LXXI	.....	×	×	×	.....	.....	.....	Sweden, Norway, Denmark, Scotland, Ireland (?), *Wales*, Newfoundland, New Brunswick, and Quebec.
sagittalis magna	46a	706	LXVI	.....	v	.....	.....	.....	.....	.....	New Brunswick.
sagittalis taconica	46b	707	LXXI	v	.....	.....	.....	.....	.....	.....	*New York* and British Columbia.
sagittalis transversa	46c	708	LXXII	.....	v	v	.....	.....	.....	.....	Newfoundland and *New Brunswick*.
cf. sagittalis	47	706	.....	.....	×	.....	.....	.....	.....	.....	Utah.
schmalenseei	48	709	Pl. LXX	.....	×	.....	.....	.....	.....	.....	Norway, *Sweden*, and Denmark.
seebachi	49	710	LXXVII	.....	.....	×	×	.....	.....	.....	*Norway* and Sweden.
shantungensis	50	710	LXIX	.....	×	.....	.....	.....	.....	.....	Shansi, Sbensi (?), and *Shantung*, China.
signalis	51	711	LXIX	.....	×	.....	.....	.....	.....	.....	Wisconsin.
socialis	52	711	LXXIII	.....	×	.....	.....	.....	.....	.....	Sweden and *Denmark*.
spinosa	53	713	LXXIX	.....	.....	×	.....	.....	.....	.....	Nevada.
subconica	54	713	LXXIII	.....	.....	.....	.....	×	.....	.....	Russia.
ulrichi	55	714	LXXVIII	.....	.....	×	.....	.....	.....	.....	Oklahoma.
uplandica	56	714	LXX	.....	×[a]	.....	.....	.....	.....	.....	Sweden.
uplandica limöensis	56a	714	LXX	.....	v[a]	.....	.....	.....	.....	.....	Do.
sp. undt.	57	715	.....	.....	×	.....	.....	.....	.....	.....	Cape Breton.
sp. undt. Westergård	58	715	.....	.....	.....	×	.....	.....	.....	.....	Sweden.
Total species				3	33	21	7	7	13	58	
Total varieties				1	10	3	1	1	5	11	
Acrothyra minor	1	717	Pl. LXXVI Fig. 59	.....	×	.....	.....	.....	.....	.....	Idaho.
proavia	2	717	Pl. LXXV, LXXVI	.....	×	.....	.....	.....	.....	.....	Cape Breton.
sera	3	718	LXXX	.....	×	.....	.....	.....	.....	.....	Do.
signata	4	719	LXXX	.....	×	.....	.....	.....	.....	.....	Do.
signata orta	4a	719	LXXX	.....	v	.....	.....	.....	.....	.....	Do.
signata prima	4b	720	LXXX	.....	v	.....	.....	.....	.....	.....	Do.
Total species				.....	4	.....	.....	.....	.....	4	
Total varieties				.....	2	.....	.....	.....	.....	2	

[a] The exact stratigraphic position of this species is not definitely known.
[b] This species also occurs in the passage beds between the Middle and Upper Cambrian.

General geographic and stratigraphic distribution of the Cambrian and Ordovician Brachiopoda—Continued.

Name.	No.	Page.	Illustration.	Stratigraphic position.					Recurrent species and varieties.	Distinct species and varieties.	General geographic position.
				Cambrian.			Passage beds.	Ordovician.			
				Lower.	Middle.	Upper.					
NEOTREMATA—Continued.											
Discinopsis gulielmi	1	720	Pl. LXXXII		×						New Brunswick.
? sulcatus	2	721	LXXXII			×					Shantung, China.
Total species					1	1				2	
Orbiculoidea contraria	1	722	Pl. LXXXI				×				Bavaria.
pileolus	2	722	LXXXI		×						North and South Wales.
varians	3	723	LXXXI				×				Bavaria.
Total species					1		2			3	
Philhedra columbiana	1	724	Pl. LXXXI		×						British Columbia.
PROTREMATA.											
Nisusia alberta	1	726	C	×	×						*British Columbia* and Utah (?).
compta	2	727	XCVII		× [a]						South Australia.
festinata	3	727	Pl. C; Fig. 6	×							Labrador, Quebec, *Vermont*, New York, Pennsylvania, and British Columbia.
festinata transversa	3a	729	Pl. C	v							Vermont.
rara	4	729	Fig. 60		×						Idaho.
? vaticina	5	730	Pl. XCVII		×						Spain.
Total species				2	4				1	5	
Total varieties				1						1	
Nisusia (Jamesella):											
amii	1	731	Pl. CI	×							Quebec.
argenta	2	731	CI	×							Nevada.
erecta	3	732	CI		×						Do.
kanabensis	4	732				×					Arizona.
kuthani	5	732	Pl. CI	×							Bohemia.
lowi	6	733	Fig. 61	×							British Columbia.
nautes	7	734	Pl. XCIII		×						*Idaho*, Utah (?), and British Columbia (?).
pellico	8	735	XCVII		×						Spain.
perpasta	9	735	CI	×							Bohemia.
perpasta macra	9a	736	CI	v							Do.
perpasta subquadrata	9b	736	CI	v							Do.
spencei	10	737	Pl. XCIII; Fig. 62		×						*Idaho* and Utah.
utahensis	11	737	Pl. CI		×						Utah.
sp. undt	12	738		×							Labrador.
Total species				6	5	1				12	
Total varieties				2						2	
Protorthis billingsi	1	739	Pl. XCIX		×						New Brunswick.
helena	2	740	XCIX		×						Do.
? hunnebergensis	3	740	XCV				×				Sweden.
lævis	4	741	XCIX			×					Wisconsin.
latourensis	5	741	XCIX		×						New Brunswick.
quacoensis	6	742	XCIX		×						Do.
wingi	7	743	XCIII			×					Vermont.
sp. undt	8	743				×					Arizona.
Total species					4	3	1			8	
Protorthis (Loperia):											
dugaldensis	1	744	Pl. XCIX		×						*Cape Breton* and New Brunswick.
Wimanella? anomala	1	745	LXXXVII		×						Alabama.
harlanensis	2	746	LXXXVII		×						Tennessee.
inyoensis	3	746	Fig. 63	×							California.
saffordi	4	747	Pl. LXXXVII		×						Tennessee.
shelbyensis	5	747	II	×							Alabama.
simplex	6	748	Pl. LXXXIX; Fig. 64	×							*Montana* and British Columbia.
Total species				3	3					6	
Billingsella? appalachia	1	750	Pl. LXXXVII		×						*Tennessee* and Georgia (?).
bivia	2	750	Fig. 65	×							California.
coloradoensis	3	751	Pl. LXXXV; Figs. 5 and 66		×	×		×			Montana, Wyoming, Idaho, Utah, *Texas*, Missouri, Wisconsin, Minnesota, British Columbia, and New Brunswick.
dice	4	754	Pl. CI					× [a]			Vermont.
exporrecta	5	754	LXXXVIII		×	×?					Sweden.
exporrecta rugosicostata	5a	755	LXXXVIII		v						Do.
hicksi	6	756	XCVII		×						South Wales.

[a] The exact stratigraphic position of this species is not definitely known.

General geographic and stratigraphic distribution of the Cambrian and Ordovician Brachiopoda—Continued.

Name.	No.	Page.	Illustration.	Stratigraphic position.					Recurrent species and varieties.	Distinct species and varieties.	General geographic position.
				Cambrian.			Passage beds.	Ordovician.			
				Lower.	Middle.	Upper.					
PROTREMATA—Continued.											
Billingsella—Cont'd.											
highlandensis	7	756	Pl. LXXXVII	×							*Nevada* and California (?).
lindströmi	8	757	LXXXVII		×						Sweden.
major	9	758	LXXXVI			×					*Wisconsin* and Missouri (?).
marion	10	758	Fig. 67		×						British Columbia.
obscura	11	758	Pl. LXXXVI		×						Arizona.
orientalis	12	759	LXXXVI	×							Vermont.
plicatella	13	759	Pl. LXXXVI, Fig. 1		×	×					*Montana* and Wyoming.
pumpellyi	14	760	Pl. XCVII			×					Shantung, China.
retroflexa	15	761	XC		×						Cape Breton.
richthofeni	16	761	LXXXIX	×							Shantung, China.
romingeri	17	762	XC		×						Bohemia.
salemensis	18	763	LXXXVII	×							Quebec and *New York*.
striata	19	764	LXXXVI		×						Montana.
whitfieldi	20	764	LXXXVI		×						Nevada.
Total species				5	12	5		2	4	20	
Total varieties					1					1	
Orusia eurekensis	1	765	Pl. CI		×						Nevada.
lenticularis	2	765	XCVIII		×	×					*Norway*, Sweden, Prussia, North Wales, Newfoundland, Cape Breton, New Brunswick, Argentina, and Nevada.
lenticularis atrypoides.	2a	769	XCVIII			v					New Brunswick.
lenticularis lynciodes.	2b	769	XCVIII			v					Do.
Total species					2	1			1	2	
Total varieties						2				2	
Otusia sandbergi	1	769	Pl. XCIII			×					*Minnesota* and Montana.
utahensis	2	770	LXXXIX		×						Utah.
Total species					1	1				2	
Wynnia warthi	1	771	Pl. LXXXIX, Fig. 68		×						India.
Eoorthis agreste	1	773	Pl. LXXXIX		×						Shantung, China.
atava	2	774	XCV			×					New Brunswick.
bavarica	3	775	XCVII				×				Bavaria.
christianiæ	4	775	XCV			×					*Norway* and Sweden.
dannus	5	776	XCV				×				East Prussia, *Norway*, and Sweden.
desmopleura	6	777	XCVI			×	×	×			*Colorado*, Utah, Montana, Wyoming, New Mexico, British Columbia (?), and Pennsylvania.
desmopleura nympha.	6a	778	XCVI			v		v			Colorado and *Wyoming*.
? diablo	7	778	XCIII			×					Wisconsin.
doris	8	779	XCVII			×					Shantung, China.
hastingsensis	9	779	XCIV		×						New Brunswick.
iddingsi	10	780	XCI			×					*Wyoming* and Texas.
indianola	11	780	XCIV			×					Missouri, *Oklahoma*, and Texas.
johannensis	12	781	XCVII			×					New Brunswick.
kayseri	13	782	XCVII			×					*Shantung* and Shansi, China.
kichouensis	14	782	LXXXIX		×						Shansi, China.
linnarssoni	15	782	XCVII			×					Shantung and *Liaotung*, China.
newberryi	16	783	Fig. 69			×					Utah.
newtonensis	17	784	Pl. XCVII			×					New Jersey.
pagoda	18	784	XCVII			×					Shantung, China.
papias	19	785	XCI		×						Newfoundland.
primordialis	20	785	XCVII		×						Spain.
remnicha	21	786	Pl. XCI, XCII, Fig. 7		×	×					Wisconsin, *Minnesota*, Montana, Utah (?), Oklahoma, and Wyoming.
remnicha sulcata	21a	787	Pl. XCII			v					*Wisconsin* and Minnesota.
remnicha texana	21b	787	XCII			v					Oklahoma, Montana, *Texas*, and Missouri (?).
remnicha winfieldensis.	21c	788	XCI			v					Wisconsin.
saltensis	22	788	XCVII			×					Argentina.
tatei	23	789	XCVII		× [a]						South Australia.
thyone	24	789	Fig. 70		×						Utah.
tullbergi	25	790	Pl. XCV				×				Sweden.
wichitaensis	26	790	XCIV		×	×		×			Colorado, *Oklahoma*, Montana, Texas, Missouri, and Wyoming.
wichitaensis lævi-usculus.	26a	791	XCIV			v					*Oklahoma* and Texas.
wimani	27	791	XCV			×	×				Sweden and *Norway*.
zeno	28	792	Fig. 71		×						Utah.
sp. undt. a	29	792			×						Bohemia.

[a] The exact stratigraphic position of this species is not definitely known.

General geographic and stratigraphic distribution of the Cambrian and Ordovician Brachiopoda—Continued.

Name.	No.	Page.	Illustration.	Stratigraphic position.					Recurrent species and varieties.	Distinct species and varieties.	General geographic position.
				Cambrian.			Passage beds.	Ordovician.			
				Lower.	Middle.	Upper.					
PROTREMATA—Continued.											
Eoorthis—Continued.											
sp. undt. b	30	792			×						Bohemia.
sp. undt. c	31	793	Pl. LXXXIX		×						Shantung, China.
sp. undt. d	32	793	LXXXIX		×						Shausi, China.
sp. undt. e	33	793				×					Shantung, China.
Total species					14	18	5	2	6	33	
Total varieties						5		1	1	5	
Finkelnburgia finkelnburgi.	1	794	Pl. XCIII			×					*Wisconsin* and Minnesota.
osceola	2	795	XCIII			×					*Wisconsin*, Minnesota, and Iowa.
osceola corrugata	2a	795				v					*Wisconsin* and Minnesota.
Total species						2				2	
Total varieties						1				1	
Eostrophomena elegantula.	1	796	Pl. XCV				×				Oeland Island, Sweden.
Swantonia antiquata	1	797	CIV	×							Vermont.
weeksi	2	797	CIV	×							Nevada.
Total species				2						2	
Syntrophia alata	1	799	Pl. CIII			×					Texas.
barahuensis	2	799	CII			×					Wisconsin.
calcifera	3	800	CIV					×			*Quebec* and Newfoundland.
cambria	4	800	Fig. 72		×						Utah.
camphelli	5	801	73			×					Tennessee.
lateralis	6	802	Pl. CII; Fig. 11					×			Vermont.
nundina	7	802	Pl. CII			×		×			*Nevada*, Utah, and Colorado.
orthia	8	803	CIV			×					Shantung, China.
primordialis	9	803	CII			×					Minnesota, *Wisconsin*, Oklahoma, and Wyoming.
primordialis argia	9a	804	CII			v					Minnesota.
rotundata	10	804	CIII			×					Wyoming.
? unxia	11	804	Fig. 74		×						Utah.
Total species					2	7		3	1	11	
Total varieties						1				1	
Huenella abnormis	1	805	Pl. CIII; Fig. 13		×	×					Montana and *Wyoming*.
billingsi	2	806	Pl. CII		×[a]						Vermont.
etheridgei	3	807	LXXXIX		×[a]						South Australia.
lesleyi	4	807	Fig. 75			×					Utah.
orientalis	5	808	Pl. CIV			×					Shantung, China.
texana	6	808	CIII			×					Texas.
texana læviusculus	6a	808				v					Do.
vermontana	7	809	Fig. 76		×						Vermont.
Total species					4	4			1	7	
Total varieties						1				1	
Clarkella montanensis	1	810	Pl. CIV					×			Montana.

[a] The exact stratigraphic position of this species is not definitely known.

SUMMARY OF CAMBRIAN BRACHIOPODA.

The distribution of the Cambrian Brachiopoda is summed up in three tables. The first (pp. 110–111) gives the general geographic and stratigraphic distribution of the genera; the second (p. 112) gives the same information for the families; and the third (p. 112) is a summary of the Cambrian Brachiopoda by genera and species.

Summary of Cambrian Brachiopoda by genera.

	Cambrian.			Passage beds.	Recurrent species and varieties.	Distinct species.	Distinct varieties.
	Lower.	Middle.	Upper.				
ATREMATA:							
RUSTELLIDÆ—							
Rustella, species	2					2	
PATERINIDÆ—							
Mickwitzia, species	3	3			1	5	
Micromitra, species	2	7	3		3	9	
Varieties			1				1
(Paterina), species	8	7	2		3	14	
Varieties	2	4			1		5
(Iphidella), species	2	3	1		2	4	
Varieties		2					2
Helmersenia, species			1			1	
Total species	15	20	7		[a] 9	33	
Total varieties	2	6	1		1		8
CURTICIDÆ—							
Curticia, species			1			1	
OBOLIDÆ—							
Obolus, species	3	29	31	6	[b] 15	54	
Varieties		3	7		[b] 2		8
(Bröggeria), species			1	1	1	1	
(Palæobolus), species		1				1	
Varieties		1					1
(Fordinia), species		2	1			3	
(Mickwitzella), species				1		1	
(Acritis), species		1		1		2	
(Schmidtia), species			4			4	
(Westonia), species	1	13	6	1	[c] 3	18	
Varieties		1					1
Lingulella, species	5	46	35	6	[d] 15	77	
Varieties		1	3				4
(Leptembolon), species			1	1	1	1	
(Lingulepis), species	1	9	5		[e] 2	13	
Varieties		2					2
Delgadella, species	1					1	
Neobolus, species		1				1	
Bicia, species	2					2	
Dicellomus, species		7	3		[f] 3	7	
Total species	13	109	87	17	40	186	
Total varieties		6	10		2		14
KUTORGINIDÆ—							
Kutorgina, species	4	2				6	
SCHUCHERTINIDÆ—							
Schuchertina, species		1				1	
NEOTREMATA:							
OBOLELLIDÆ—							
Obolella, species	11					11	
Varieties	1						1
(Glyptias), species	1					1	
Botsfordia, species	1	4			1	4	
Schizopholis, species		1				1	
Quebecia, species	1					1	
Total species	14	5			1	18	
Total varieties	1						1

[a] Two species pass up from the Lower to the Middle Cambrian, four from the Middle to the Upper Cambrian, and one from the Lower to the Upper Cambrian. One species is common to the Lower, Middle, and Upper Cambrian. One variety passes from the Lower to the Middle Cambrian.

[b] Fourteen species pass from the Middle to the Upper Cambrian and one continues into the passage beds. Four of these species pass up from the Upper Cambrian to the Ordovician.

[c] One species is common to the Lower, Middle, and Upper Cambrian, and one species passes from the Middle to the Upper Cambrian. One species passes from the Upper Cambrian to the Ordovician.

[d] Two species are common to the Middle and Upper Cambrian and pass up into the Ordovician; eleven species pass from the Middle to the Upper Cambrian; two species pass from the Upper Cambrian to the passage beds; and two species pass from the Upper Cambrian to the Ordovician.

[e] Two species are common to the Middle and Upper Cambrian and pass up into the Ordovician.

[f] One species is common to the Middle and Upper Cambrian; two species pass from the Middle to the Upper Cambrian; and one species passes from the Upper Cambrian to the Ordovician.

Summary of Cambrian Brachiopoda by genera—Continued.

	Cambrian.			Passage beds.	Recurrent species and varieties.	Distinct species.	Distinct varieties.
	Lower.	Middle.	Upper.				
NEOTREMATA—Continued.							
SIPHONOTRETIDÆ—							
Yorkia, species	2	1		1		4	
Dearbornia, species		1				1	
Trematobolus, species	1	3				4	
Schizambon, species			3		(*a*)	3	
Siphonotreta, species	1			2	(*b*)	3	
Keyserlingia, species			1			1	
Total species	4	5	4	3		16	
Total varieties							
ACROTRETIDÆ—							
Acrothele, species	10	21	3	2	*c* 4	32	
Varieties	1	6					7
(Redlichella), species		1				1	
Discinolepis, species		1				1	
Linnarssonella, species		3	6		*d* 2	7	
Acrotreta, species	3	33	21	7	*e* 11	53	
Varieties	1	10	3	1	*f* 4		11
Acrothyra, species		4				4	
Varieties		2					2
Discinopsis, species		1	1			2	
Total species	13	64	31	9	17	100	
Total varieties	2	18	3	1	4		20
DISCINIDÆ—							
Orbiculoidea, species		1		2		3	
CRANIIDÆ—							
Philhedra, species		1				1	
PROTREMATA:							
BILLINGSELLIDÆ—							
Nisusia, species	2	4			1	5	
Varieties	1						1
(Jamesella), species	6	5	1			12	
Varieties	2						2
Protorthis, species		4	3	1		8	
(Loperia), species		1				1	
Wimanella, species	3	3				6	
Billingsella, species	5	12	5		*g* 3	19	
Varieties		1					1
Orusia, species		2	1		1	2	
Varieties			2				2
Otusia, species		1	1			2	
Wynnia, species		1				1	
Eoorthis, species		14	18	5	*h* 4	33	
Varieties			5		(*h*)		5
Finkelnburgia, species			2			2	
Varieties			1				1
Total species	16	47	31	6	8	91	
Total varieties	3	1	8				12
STROPHOMENIOÆ—							
Eostrophomena, species				1		1	
SYNTROPHIIDÆ—							
Swantonia, species	2					2	
Syntrophia, species		2	7		(*i*)	9	
Varieties			1				1
Huenella, species		4	4		1	7	
Varieties			1				1
Total species	2	6	11		1	18	
Total varieties			2				2

a One species passes from the Upper Cambrian to the Ordovician.
b Two species pass from the passage beds to the Ordovician.
c One species passes up from the Lower to the Middle Cambrian; two from the Middle to the Upper Cambrian; and one from the Middle Cambrian to the passage beds.
d Two species pass from the Middle to the Upper Cambrian and one species passes from the Upper Cambrian to the Ordovician.
e Six species pass from the Middle to the Upper Cambrian, of which one continues on into the passage beds; one species passes from the Lower to the Middle Cambrian, and one from the Upper Cambrian to the passage beds. One species is common to the Middle and Upper Cambrian and to the Ordovician; one species is common to the Upper Cambrian and the passage beds; and one species passes from the Upper Cambrian to the Ordovician.
f Two varieties pass from the Middle to the Upper Cambrian and one variety is common to the Middle Cambrian, Upper Cambrian, and passage beds.
g Two species pass from the Middle to the Upper Cambrian of which one continues into the Ordovician. One species passes from the Lower to the Middle Cambrian.
h One species passes from the Middle to the Upper Cambrian; one species is common to the Upper Cambrian, passage beds, and Ordovician; one species is common to the Middle Cambrian, Upper Cambrian, and Ordovician; one species passes from the Upper Cambrian to the passage beds; one variety is common to the Upper Cambrian and the Ordovician.
i One species is common to the Upper Cambrian and the Ordovician.

Summary of Cambrian Brachiopoda by families.

	Cambrian.			Passage beds.	Genera, subgenera, species, and varieties.	
	Lower.	Middle.	Upper.		Recurrent.	Distinct.
ATREMATA:						
RUSTELLIDÆ—						
Genera	1					1
Species	2					2
PATERINIDÆ—						
Genera	2	2	2		3	3
Subgenera	2	2	2		4	2
Species	15	20	7		9	33
Varieties	2	6	1		1	8
CURTICIIDÆ—						
Genera			1			1
Species			1			1
OBOLIDÆ—						
Genera	4	4	3	3	8	6
Subgenera	2	5	5	5	8	9
Species	13	109	87	17	40	186
Varieties		8	10		2	16
KUTORGINIDÆ—						
Genera	1	1			1	1
Species	4	2				6
SCHUCHERTINIDÆ—						
Genera		1				1
Species		1				1
NEOTREMATA:						
OBOLELLIDÆ—						
Genera	3	2			1	4
Subgenera	1					1
Species	14	5			1	18
Varieties	1					1
SIPHONOTRETIDÆ—						
Genera	3	3	2	2	4	6
Species	4	5	4	3		16
ACROTRETIDÆ—						
Genera	2	6	4	2	8	6
Subgenera		1				1
Species	13	64	31	9	17	100
Varieties	2	18	3	1	4	20
DISCINIDÆ—						
Genera		1		1	1	1
Species		1		2		3
CRANIIDÆ—						
Genera		1				1
Species		1				1
PROTREMATA:						
BILLINGSELLIDÆ—						
Genera	3	8	6	2	10	9
Subgenera	1	2	1		2	2
Species	16	47	31	6	8	91
Varieties	3	1	8			12
STROPHOMENIDÆ—						
Genera				1		1
Species				1		1
SYNTROPHIIDÆ—						
Genera	1	2	2		2	3
Species	2	6	11		1	18
Varieties			2			2

General summary of Cambrian Brachiopoda.

	Genera.	Subgenera.	Species.	Varieties.	Species and varieties that pass on into the Ordovician.
Atremata:					
Rustellidæ	1		2		
Paterinidæ	3	2	33	8	
Curticiidæ	1		1		
Obolidæ	6	9	186	16	12
Kutorginidæ	1		6		
Schuchertinidæ	1		1		
Neotremata:					
Obolellidæ	4	1	18	1	
Siphonotretidæ	6		16		3
Acrotretidæ	6	1	100	20	4
Discinidæ	1		3		
Craniidæ	1		1		
Protremata:					
Billingsellidæ	9	2	91	12	4
Strophomenidæ	1		1		
Syntrophiidæ	3		18	2	1
Total	44	15	477	59	24

SUMMARY OF ORDOVICIAN BRACHIOPODA.

The Ordovician Brachiopoda are summarized in two tables, one by genera and the other by families:

Summary of Ordovician Brachiopoda by genera.

	Species.	Varieties.	Species and varieties that pass up from Cambrian.
ATREMATA:			
PATERINIDÆ—			
Volborthia[a]	1		
OBOLIDÆ—			
Obolus	16		4
(Lingulobolus)[a]	2		
(Westonia)	5		1
Lingulella	13		5
(Lingulepis)	1	1	1
Elkania[a]	3		
Dicellomus	1		1
NEOTREMATA:			
SIPHONOTRETIDÆ—			
Schizambon	2		1
Siphonotreta	2		2
ACROTRETIDÆ—			
Acrothele	2		
Linnarssonella	1		1
Acrotreta	7	1	3
PROTREMATA:			
BILLINGSELLIDÆ—			
Billingsella	2		1
Eoorthis	2	1	3
SYNTROPHIIDÆ—			
Syntrophia	3		1
Clarkella[a]	1		
Total	64	3	24

[a] Found only in the Ordovician.

Summary of Ordovician Brachiopoda by families.[a]

	Genera.	Subgenera.	Species.	Varieties.	Species and varieties that pass up from Cambrian.
Atremata:					
Paterinidæ	1		1		
Obolidæ	4	3	41	1	12
Neotremata:					
Siphonotretidæ	2		4		3
Acrotretidæ	3		10	1	4
Protremata:					
Billingsellidæ	2		4	1	4
Syntrophiidæ	2		4		1
Total	14	3	64	3	24

[a] This table includes all Ordovician species taken up in the monograph. With the exception of three genera, one subgenus, forty-two species, and one variety all of these pass up from the Cambrian. (See pp. 122–123 for a list of the Ordovician forms taken up in this monograph.)

GENERAL SUMMARY OF CAMBRIAN AND ORDOVICIAN BRACHIOPODA.

The following table gives a general summary of the genera, subgenera, species, and varieties, both Cambrian and Ordovician, in each of the families taken up in this monograph:

General summary of Cambrian and Ordovician Brachiopoda.

	Genera.	Subgenera.	Species.	Varieties.
Atremata:				
Rustellidæ	1		2	
Paterinidæ	4	2	34	8
Curticiidæ	1		1	
Obolidæ	7	10	215	17
Kutorginidæ	1		6	
Neotremata:				
Schuchertinidæ	1		1	
Obolellidæ	4	1	18	1
Siphonotretidæ	6		17	
Acrotretidæ	6	1	107	20
Discinidæ	1		3	
Craniidæ	1		1	
Protremata:				
Billingsellidæ	9	2	92	12
Strophomenidæ	1		1	
Syntrophiidæ	4		21	2
Total	47	16	519	60

DETAILED GEOGRAPHIC DISTRIBUTION.

In the following lists the various species of Cambrian Brachiopoda are listed by continents, as they occur in the various faunal provinces of Cambrian time in North America and in other countries. The record of the local distribution of each species will be found at the end of the description of the species.

The tables are arranged under the following heads, the species being zoologically arranged under each head:

1. North American species of Cambrian Brachiopoda (p. 114).
2. European species of Cambrian Brachiopoda (p. 120).
3. Asiatic species of Cambrian Brachiopoda (p. 121).
4. South American species of Cambrian Brachiopoda (p. 122).
5. Australian species of Cambrian Brachiopoda (p. 122).
6. North American species of Ordovician Brachiopoda (p. 122).[a]
7. European species of Ordovician Brachiopoda (p. 123).[a]

CAMBRIAN BRACHIOPODA.

NORTH AMERICAN SPECIES.

Geographic distribution of North American species of Cambrian Brachiopoda.

NOTE.—The letters placed opposite each species in the various columns denote the State or province in which the species occurs; for instance, a "C" in column 2 under A indicates that the species occurs in Cape Breton, "CN" indicates that it occurs in both Cape Breton and New Brunswick.

	Provinces in which each species occurs.	A. Atlantic coast province.			B. Appalachian province.				C. Rocky Mountain province.			D. Interior continental province.						
		1. Newfoundland.	2. Cape Breton and New Brunswick.	3. Massachusetts and Rhode Island.	1. Labrador and Quebec.	2. Vermont and New York.	3. New Jersey, Pennsylvania, Maryland, and Virginia.	4. Tennessee, Georgia, and Alabama.	1. British Columbia and Alberta.	2. Montana.	3. Idaho, Utah, Nevada, and California.	1. Ontario and New York.	2. Wisconsin, Minnesota, and Iowa.	3. Missouri.	4. Oklahoma.	5. Texas.	6. Arizona and New Mexico.	7. Colorado, Wyoming, and South Dakota.
Rustella edsoni Walcott	B					V	P											
major (Matthew)	A		N															
Mickwitzia occidens Walcott	C										CN							
Micromitra alabamaensis (Walcott)	B							TA										
haydeni Walcott	C										I							
nisus (Walcott)	B				Q													
pealei (Walcott)	CD									M							A	W
sculptilis (Meek)	CD									M	UN							W
sculptilis endlichi Walcott	C										N							
zenobia Walcott	C								B									
sp. undt. Walcott	D																	W
Micromitra (Paterina) bella (Billings)	AB	N		M	LQ	V	P											
crenistria (Walcott)	BCD							T			NU?						A	
labradorica (Billings)	ABC and Europe.	N	N		LQ	N			B		N							
labradorica swantonensis (Walcott)	B					V												
labradorica utahensis (Walcott)	C										U							
labradorica var. undt. (Walcott)	C										N							
logani (Walcott)	B				Q													
major (Walcott)	B							A										
prospectensis (Walcott)	C										N							
stissingensis (Dwight)	BCD					N			B?					M?				
stissingensis ora Walcott	C								B									
stuarti Walcott	C										U							
superba (Walcott)	CD									M	U						A	
wapta Walcott	C								B									
williardi Walcott	B							A										
Micromitra (Iphidella) louise Walcott	C								A									
nyssa Walcott	C									M								
ornatella (Linnarsson)	A and Europe.	N																
pannula (White)	ABCD		C?			N		GT	B	M	IUN						A	
pannula maladensis (Walcott)	AC	N									I							
pannula ophirensis (Walcott)	C and China.								B		IU							

[a] Only those taken up in this monograph.

Geographic distribution of North American species of Cambrian Brachiopoda—Continued.

NOTE.—The letters placed opposite each species in the various columns denote the State or province in which the species occurs; for instance, a "C" in column 2 under A indicates that the species occurs in Cape Breton, "CN" indicates that it occurs in both Cape Breton and New Brunswick.

	Provinces in which each species occurs.	A. Atlantic coast province.			B. Appalachian province.				C. Rocky Mountain province.			D. Interior continental province.						
		1.	2.	3.	1.	2.	3.	4.	1.	2.	3.	1.	2.	3.	4.	5.	6.	7.
		Newfoundland.	Cape Breton and New Brunswick.	Massachusetts and Rhode Island.	Labrador and Quebec.	Vermont and New York.	New Jersey, Pennsylvania, Maryland, and Virginia.	Tennessee, Georgia, and Alabama.	British Columbia and Alberta.	Montana.	Idaho, Utah, Nevada, and California.	Ontario and New York.	Wisconsin, Minnesota, and Iowa.	Missouri.	Oklahoma.	Texas.	Arizona and New Mexico.	Colorado, Wyoming, and South Dakota.
Curticia elegantula Walcott	D												M					
Obolus acadicus Walcott	A		C															
discoideus (Hall and Whitfield)	C and Ord.									M	IUN							
fragilis (Walcott)	A	N																
ismene Walcott	D													M				
lamborni (Meek)	BD						V	TG						M				
lamborni minimus (Walcott)	B							T										
loperi Walcott	D																	C
mcconnelli (Walcott)	C								BA	M	UNC							
mcconnelli decipiens Walcott	C										NC							
mcconnelli pelias (Walcott)	C									M	UN							
mæra (Hall and Whitfield)	B? and CD					V?					N							C
matinalis (Hall)	BCD, China?, and Ord.					V?	V			M	IU		WM	M?	O	T		W
membranaceus Walcott	C								B									
mickwitzi Walcott	D												W					
namouna Walcott	D												WM					
nundina Walcott	CD										N					T		
pandemia Walcott	B							T										
parvus Walcott	C								BA									
pheres Walcott	D												W					
prindlei (Walcott)	B					NV?												
refulgens Matthew	A		CN															
rhea Walcott	D												WM					
rotundatus (Walcott)	BCD							G		M	UN							W
selwyni (Matthew)	A		C															
septalis (Walcott)	C								B									
sinoe (Walcott)	D							TA						M		T	N	W
smithi Walcott	B							A										
tetonensis Walcott	CD									M	U						A	W
tetonensis leda Walcott	C										U							
tetonensis ninus Walcott	CD										I				O	T		
? torrentis Matthew	A		C															
willisi (Walcott)	B							TGA										
wortheni Walcott	C										I							
zetus (Walcott)	D																A	
sp. undt. b	C										N							
sp. undt. d	B					V												
Obolus (Bröggeria) salteri (Holl)	A and Europe.		C															
Obolus (Palæobolus) bretonensis (Matthew).	A		C															
bretonensis leus (Matthew)	A		C															
Obolus (Fordinia) bellulus (Walcott)	C										NU?							
gilberti Walcott	C										U							
perfectus Walcott	C										U							
Obolus (Acritis?) rugatus Walcott	C										N							
Obolus (Westonia) aurora (Hall)	D												WM					
chuarensis (Walcott)	D																A	
dartoni Walcott	D																	W
ella (Hall and Whitfield)	BCD							TA	B	M	IUN							W
ella onaquiensis Walcott	C										U							
escasoni (Matthew)	A		C															
euglyphus (Walcott)	D																A	
iphis Walcott	C and Ord.										UN							
stoneanus (Whitfield)	BD						N						W				N	
themis Walcott	D																A	
wasatchensis Walcott	C										IU							
sp. undt. b Walcott	C										N							
Lingulella acutangula (Roemer)	CD										N?			M		T	AN?	
ampla (Owen)	D												WM					S?
arguta (Walcott)	C										UN							
atava (Matthew)	A		C															
atava insulæ (Matthew)	A		C															
auga (Walcott)	B							T										
bella (Walcott)	A	N		R														
bellula (Walcott)	A	N																
billingsiana (Whiteaves)	A	N																
buttsi Walcott	B							A										
cania (Walcott)	A		C															
clarkei Walcott	C										N							
collicia (Matthew)	A		C															
concinna Matthew	A and Europe?		C															

Geographic distribution of North American species of Cambrian Brachiopoda—Continued.

NOTE.—The letters placed opposite each species in the various columns denote the State or province in which the species occurs; for instance, a "C" in column 2 under A indicates that the species occurs in Cape Breton, "CN" indicates that it occurs in both Cape Breton and New Brunswick.

	Provinces in which each species occurs.	A.			B.				C.			D.						
		Atlantic coast province.			Appalachian province.				Rocky Mountain province.			Interior continental province.						
		1.	2.	3.	1.	2.	3.	4.	1.	2.	3.	1.	2.	3.	4.	5.	6.	7.
		Newfoundland.	Cape Breton and New Brunswick.	Massachusetts and Rhode Island.	Labrador and Quebec.	Vermont and New York.	New Jersey, Pennsylvania, Maryland, and Virginia.	Tennessee, Georgia, and Alabama.	British Columbia and Alberta.	Montana.	Idaho, Utah, Nevada, and California.	Ontario and New York.	Wisconsin, Minnesota, and Iowa.	Missouri.	Oklahoma.	Texas.	Arizona and New Mexico.	Colorado, Wyoming, and South Dakota.
Lingulella—Continued.																		
cuneola (Whitfield)	D																	S
davisi (McCoy)	A, Europe, Asia, and South America.		C															
desiderata (Walcott)	B, C, D, and Ord.							TGA	B	M	INU			M				WS
dubia (Walcott)	C										N							
ferruginea Salter	A, South America, and Europe.	N	CN															
fiumenis (Matthew)	A		C															
franklinensis (Walcott)	B					V												
granvillensis Walcott	B					NV												
hayesi Walcott	B							A										
helena (Walcott)	CD									M	IU							W
ino (Walcott)	B							TG										
iris (Billings)	B				Q													
isse (Walcott)	C								B		IUN							
lævis Matthew	A		N															
lævis grandis Matthew	A		CN															
lens (Matthew)	A		C															
leos (Walcott)	B							G										
lepis (Salter)	A and Europe.		CN															
lineolata (Walcott)	D																A	
manticula (White)	C and Ord.										I?UN							
martinensis Matthew	A		N															
minor (Matthew)	A		CN															
mosia (Hall)	D and Ord												WMI					
mosia osceola (Walcott)	D												W					
nanno (Walcott)	B							A										
ora (Walcott)	D													M?	O			
oweni (Walcott)	D												WM			T	A	S
perattenuata (Whitfield)	D																	
phaon (Walcott)	D												WM					
pogonipensis (Walcott)	C and D?										UN						A?	
prima (Hall)	B					N												
punctata (Walcott)	C										N							
quadrilateralis (Walcott)	B							GA										
radula Matthew	A		CN															
randomensis (Walcott)	A	N																
rotunda (Matthew)	A		C															
schucherti (Walcott)	B					N												
similis (Walcott)	BCD							TGA			NU?		WM	M	O			CS
tarpa (Walcott)	B							T										
texana Walcott	D													M		T		
torrentis (Matthew)	A		C															
triparilis (Matthew)	A		C															
tumida Matthew	A		C															
upis (Walcott)	D															T		
welleri (Walcott)	B						N											
winona (Hall)	D												WMI					
winona convexa (Walcott)	D												W				A	
sp. undt. b Walcott	B						P											
Lingulella (Lingulepis) acuminata (Conrad).	B, C, D, and Ord.					VN	V	TA		M	UN	ON	WM [a]		O	T		CWS
acuminata meeki (Walcott)	D																	W
exigua (Matthew)	A		C															
gregwa (Matthew)	A		C															
gregwa robusta (Matthew)	A		C															
longinervis (Matthew)	A		C															
pumila (Matthew)	A		C															
roberti (Matthew)	A		C															
rowei (Walcott)	C										C							
spatula (Walcott)	D																A	
starri (Matthew)	A		N															
Bicia gemma (Billings)	B				LQ	N												
whiteavesi Walcott	B					N												

[a] *Lingulella (Lingulepis) acumtnata* also occurs in Michigan.

Geographic distribution of North American species of Cambrian Brachiopoda—Continued.

NOTE.—The letters placed opposite each species in the various columns denote the State or province in which the species occurs; for instance, a "C" in column 2 under A indicates that the species occurs in Cape Breton, "CN" indicates that it occurs in both Cape Breton and New Brunswick.

	Provinces in which each species occurs.	A. Atlantic coast province.			B. Appalachian province.				C. Rocky Mountain province.			D. Interior continental province.						
		1. Newfoundland.	2. Cape Breton and New Brunswick.	3. Massachusetts and Rhode Island.	1. Labrador and Quebec.	2. Vermont and New York.	3. New Jersey, Pennsylvania, Maryland, and Virginia.	4. Tennessee, Georgia, and Alabama.	1. British Columbia and Alberta.	2. Montana.	3. Idaho, Utah, Nevada, and California.	1. Ontario and New York.	2. Wisconsin, Minnesota, and Iowa.	3. Missouri.	4. Oklahoma.	5. Texas.	6. Arizona and New Mexico.	7. Colorado, Wyoming, and South Dakota.
Dicellomus appalachia Walcott	B							TA										
nanus (Meek and Hayden)	C, D, and Ord.									M				M				WS
pectenoides (Whitfield)	CD									M			W					S
politus (Hall)	BCD							T		M	U		WM	M	O		A	S
prolificus Walcott	C										U							
Kutorgina cingulata (Billings)	B, C, and Asia.				LQ	V			B		N							
granulata Matthew	A		N															
perugata Walcott	C										NC							
sp. undt. Walcott	B						V											
Schuchertina cambria Walcott	C									M								
Obolella atlantica Walcott	AB	N		M				G										
chromatica Billings	AB	N			L	N												
crassa (Hall)	AB			M	LQ	VN	P?	G?										
crassa elongata Walcott	B				Q													
minor (Walcott)	B					N	P[a]											
vermilionensis Walcott	C								A		C							
Botsfordia cælata (Hall)	AB		N		Q	VN												
pulchra (Matthew)	A		N															
Quebecia circe (Billings)	B				LQ													
Yorkia wanneri Walcott	B and C?				Q?		P				C?							
? washingtonensis Walcott	B					N												
Dearbornia clarki Walcott	C									M								
Trematobolus excelsis Walcott	C										C							
insignis Matthew	A		N															
kempanum (Matthew)	A		N															
pristinus (Matthew)	A		N															
Schizambon priscus Matthew	A		CN															
typicalis Walcott	C and Ord.										U							
Siphonotreta? duhia Walcott	C										N							
Acrothele artemis Walcott	C										I							
avia Matthew	A		C															
avia puteis Matthew	A		C															
bellula Walcott	B							A										
colleni Walcott	C								BA	M								
decipiens Walcott	B						P											
dichotoma Walcott	C										N							
gamagei (Hobbs)	A			M														
matthewi (Hartt)	A	N	N															
matthewi lata Matthew	A		N															
matthewi multicostata Matthew	A		N															
nitida (Ford)	B					N												
panderi Walcott	C									M								
prima (Matthew)	A		CN															
prima costata (Matthew)	A	N	N															
proles Matthew	A		C															
spurri Walcott	C										N							
subsidua (White)	C								B		IU							
subsidua hera Walcott	C										N							
subsidua lævis Walcott	C										U							
turneri Walcott	C										NU?							
woodworthi Walcott	A			M														
yorkensis Walcott	B						P											
sp. undt. a Walcott	B				Q													
Linnarssonella girtyi Walcott	CD										U			M	O			S
minuta (Hall and Whitfield)	C and Ord.										N							
modesta Walcott	C										U							
nitens Walcott	C										U							
tennesseensis Walcott	BC							T			U							
transversa Walcott	C										U							
urania Walcott	C										U							
Acrotreta argenta Walcott	C										N							
attenuata Meek	CD									M	UN							W
attenuata var. Walcott	C									M								
baileyi Matthew	A		N															
bellatula Walcott	C										U							
bisecta Matthew	A		CN															
?? cancellata Walcott	C										N							
claytoni Walcott	C										N							

[a] This species also occurs in Virginia and Maryland.

Geographic distribution of North American species of Cambrian Brachiopoda—Continued.

NOTE.—The letters placed opposite each species in the various columns denote the State or province in which the species occurs; for instance, a "C" in column 2 under A indicates that the species occurs in Cape Breton, "CN" indicates that it occurs in both Cape Breton and New Brunswick.

	Provinces in which each species occurs.	A. Atlantic coast province.			B. Appalachian province.				C. Rocky Mountain province.			D. Interior continental province.						
		1. Newfoundland.	2. Cape Breton and New Brunswick.	3. Massachusetts and Rhode Island.	1. Labrador and Quebec.	2. Vermont and New York.	3. New Jersey, Pennsylvania, Maryland, and Virginia.	4. Tennessee, Georgia, and Alabama.	1. British Columbia and Alberta.	2. Montana.	3. Idaho, Utah, Nevada, and California.	1. Ontario and New York.	2. Wisconsin, Minnesota, and Iowa.	3. Missouri.	4. Oklahoma.	5. Texas.	6. Arizona and New Mexico.	7. Colorado, Wyoming, and South Dakota.
Acrotreta—Continued.																		
concentrica Walcott	B							G										
convexa Walcott	A		C															
curvata Walcott	C and D?										N				O?			
definita Walcott	CD										IN							W
depressa (Walcott)	C								B									
emmonsi Walcott	B					N												
gemmula Matthew	A		CN															
gracia Walcott	A		N															
idahoensis Walcott	CD and Ord.									M	IUN							WS
idahoensis alta Walcott	C										UN							
idahoensis sulcata Walcott	C										IU							
cf. idahoensis Walcott	C										N							
inflata (Matthew)	A		N															
kutorgai Walcott	B							TA										
marjumensis Walcott	C										U							
microscopica (Shumard)	CD										N				O	T		
microscopica missouriensis Walcott	D													M				
microscopica tetonensis Walcott	D																	W
misera (Billings)	A	N	N															
neboensis Walcott	C										U							
nox Walcott	D												W					
ophirensis Walcott	C										U							
ophirensis descendens Walcott	C										U							
ophirensis rugosa Walcott	C										U							
cf. ophirensis Walcott	C										U							
primæva Walcott	C										N							
pyxidicula White	C									M	IUN							
rudis Walcott	B							T										
sagittalis (Salter)	A, B, and Europe.	N	N		Q													
sagittalis magna (Matthew)	A		N															
sagittalis taconica (Walcott)	BC					N			B									
sagittalis transversa (Hartt)	A	N	N															
cf. sagittalis	C										U							
signalis Walcott	D												W					
spinosa Walcott	C										N							
ulrichi Walcott	D														O			
sp. undt. Walcott	A		C															
Acrothyra minor Walcott	C										I							
proavia (Matthew)	A		C															
sera (Matthew)	A		C															
signata Matthew	A		C															
signata orta Matthew	A		C															
signata prima Matthew	A		C															
Discinopsis gulielmi (Matthew)	A		N															
Philhedra columbiana (Walcott)	C								B									
Nisusia alberta Walcott	C								B		U							
festinata (Billings)	BC				LQ	VN	P		B									
festinata transversa (Walcott)	B					V												
rara Walcott	C										I							
Nisusia (Jamesella) amii Walcott	B				Q													
argenta Walcott	C										N							
erecta Walcott	C										N							
? kanabensis Walcott	D																A	
lowi Walcott	C								B									
nantes (Walcott)	C								B?		IU?							
spencei (Walcott)	C										IU							
utahensis Walcott	C										U							
sp. undt. Walcott	B				L													
Protorthis billingsi (Hartt)	A		N															
helena Walcott	A		N															
lævis Walcott	D												W					
latourensis (Matthew)	A		N															
quacoensis (Matthew)	A		N															
wingi Walcott	B					V												
sp. undt. Walcott	D																A	
Protorthis (Loperia) dugaldensis Walcott	A		CN															
Wimanella? anomala (Walcott)	B							A										
harlanensis (Walcott)	B							T										
inyoensis Walcott	C										C							

Geographic distribution of North American species of Cambrian Brachiopoda—Continued.

NOTE.—The letters placed opposite each species in the various columns denote the State or province in which the species occurs; for instance, a "C" in column 2 under A indicates that the species occurs in Cape Breton, "CN" indicates that it occurs in both Cape Breton and New Brunswick.

	Provinces in which each species occurs.	A. Atlantic coast province.			B. Appalachian province.				C. Rocky Mountain province.			D. Interior continental province.						
		1. Newfoundland.	2. Cape Breton and New Brunswick.	3. Massachusetts and Rhode Island.	1. Labrador and Quebec.	2. Vermont and New York.	3. New Jersey, Pennsylvania, Maryland, and Virginia.	4. Tennessee, Georgia, and Alabama.	1. British Columbia and Alberta.	2. Montana.	3. Idaho, Utah, Nevada, and California.	1. Ontario and New York.	2. Wisconsin, Minnesota, and Iowa.	3. Missouri.	4. Oklahoma.	5. Texas.	6. Arizona and New Mexico.	7. Colorado, Wyoming, and South Dakota.
Wimanella—Continued.																		
saffordi (Walcott)	B							T										
shelbyensis Walcott	B							A										
simplex Walcott	C								B	M								
Billingsella? appalachia Walcott	B							TG										
bivia Walcott	C										C							
coloradoensis (Shumard)	ACD and Ord.		N						B	M	IU		WM	M		T		W
highlandensis (Walcott)	C										NC			M?				
major Walcott	D												W					
marion Walcott	C								B									
obscura Walcott	D																A	
orientalis (Whitfield)	B					V												
plicatella Walcott	C									M								W
retroflexa (Matthew)	A		C															
salemensis (Walcott)	B				Q	N												
striata Walcott	C									M								
whitfieldi (Walcott)	C										N							
Orusia? eurekensis (Walcott)	C										N							
lenticularis (Wahlenberg)	A, C, South America, and Europe.	N	CN								N							
lenticularis atrypoides (Matthew)	A		N															
lenticularis lyncioides (Matthew)	A		N															
Otusia sandbergi (Winchell)	D												M					
utahensis Walcott	C									M	U							
Eoorthis atava (Matthew)	A		N															
desmopleura (Meek)	B, C, D, and Ord.						P		B	M	U						N	W
desmopleura nympha (Walcott)	D and Ord.																	W
? diablo (Walcott)	D												W					
hastingsensis (Walcott)	A		N															
iddingsi (Walcott)	D															T		W
indianola (Walcott)	D													M	O	T		
johannensis (Matthew)	A		N															
newberryi Walcott	C										U							
newtonensis (Weller)	B						N											
papias (Walcott)	A	N																
remnicha (Winchell)	CD									M	U?		WM		O			W
remnicha sulcata (Walcott)	D												WM					
remnicha texana (Walcott)	CD									M				M	O	T		
remnicha winfieldensis (Walcott)	D												W					
thyone Walcott	C										U							
wichitaensis (Walcott)	C, D, and Ord.									M				M	O	T		W
wichitaensis læviusculus (Walcott)	D														O	T		
zeno Walcott	C										U							
Finkelnburgia finkelnburgi (Walcott)	D												WM					
osceola (Walcott)	D												WM					
osceola corrugata (Walcott)	D												WM					
Swantonia antiquata (Billings)	B					V												
weeksi Walcott	C										N							
Syntrophia alata Walcott	D															T		
barabuensis (A. Winchell)	D												W					
cambria Walcott	C										U							
campbelli Walcott	B							T										
nundina Walcott	C and Ord.										U							
primordialis (Whitfield)	D												WM		O			W
primordialis argia Walcott	D												M					
rotundata Walcott	D																	W
? unxia Walcott	C										U							
Huenella abnormis (Walcott)	CD									M								W
billingsi (Walcott)	B					V												
lesleyi (Walcott)	C										U							
texana (Walcott)	D															T		
texana læviusculus (Walcott)	D															T		
vermontana Walcott	B					V												

EUROPEAN SPECIES.

Geographic distribution of European species of Cambrian Brachiopoda.

NOTE.—The letters placed opposite each species in the various columns denote the country or province in which the species occurs; for instance, in the third column an "S" indicates that the species occurs in Sweden, "SF" indicates that it occurs in both Sweden and Finland, etc.

	England, Scotland, Ireland, and Wales.	Norway, Sweden, Denmark, and Finland.	Russia and Poland.	Prussia.	Bohemia.	Bavaria.	France.	Sardinia.	Spain and Portugal.	Also occurs in—
Mickwitzia formosa (Wiman)		SF								
monilifera (Linnarsson)		SF	R							
pretiosa Walcott		S								
? sp. undt. Walcott								S		
Micromitra pusilla (Linnarsson)	E	SD								
scotica Walcott	S									
Micromitra (Paterina) labradorica (Billings)	E									North America.
phillipsi (Holl)	E									
undosa (Moberg)		S								
Micromitra (Iphidella) ornatella (Linnarsson)		SD								North America.
Volborthia recurva (Kutorga)			R							
Helmersenia ladogensis (Jeremejew)			R							
Obolus apollinis Eichwald		SF	RP	P						
apollinis ingricus (Eichwald)			R							
apollinis maximus Mickwitz			R							
apollinis quenstedti (Mickwitz)			R							
? bavaricus (Barrande)						B				
eichwaldi Mickwitz			R							
elegans Mickwitz			R							
? inflatus Westergård		S								
? meneghinii Walcott								S		
? minor Barrande						B				
? palliatus Barrande						B				
panderi Mickwitz			R							
schmalenseei (Walcott)		SD								
schmidti Mickwitz			R							
triangularis Mickwitz		S	R							
volborthi Mickwitz			R							
? zoppi Walcott								S		
sp. undt. g		S								
Obolus (Bröggeria) salteri (Holl)	E	NS								North America.
Obolus (Mickwitzella) siluricus (Eichwald)			RP							
Obolus (Acritis) antiquissimus (Eichwald)			R							
Obolus (Schmidtia) acuminatus Mickwitz			R							
celatus (Volborth)		S	R							
crassus Mickwitz			R							
obtusus Mickwitz		S	R							
Obolus (Westonia) ålandensis Walcott		SF								
balticus Walcott		SF								
bottnicus (Wiman)		SF								
finlandensis Walcott		F								
wimani Walcott		SF								
Lingulella agnostorum (Wallerius)		S								
bornemanni (Walcott)								S		
cedens (Barrande)						B				
concinna Matthew		S?								North America.
davisi (McCoy)	EW									North and South America and China.
delgadoi Walcott									P	
ferruginea Salter	W	NSD								North and South America.
cf. ferruginea Walcott					B					
? humillima (Barrande)						B				
lepis (Salter)	W	NS								North America.
linnarssoni (Walcott)		S								
nathorsti Linnarsson		S								
nicholsoni Callaway	E									
? primæva Hicks	W									
siemiradzkii (Walcott)			P							
signata (Barrande)						B				
wirthi (Barrande)						B				
zeus Walcott	S									
sp. undt. a Walcott		S								
Lingulella (Leptembolon) lingulæformis (Mickwitz)			R							
Lingulella (Lingulepis) pygmæa (Salter)	E									
? squamosa (Holl)	E									
Delgadella lusitanica (Delgado)									P	
Dicellomus sp. undt. Walcott		S								
Kutorgina sardiniaensis Walcott								S		
Obolella? lindströmi Walcott		S								
mobergi Walcott		NS								
? sp. undt. Walcott									P	
Obolella (Glyptias) favosa (Linnarsson)		NS								
Botsfordia? barrandei Walcott									S	
Yorkia? miqueli Walcott							F			
Schizambon? esthonia Walcott			R							
Siphonotreta unguiculata (Eichwald)			R	P						Ordovician.
verrucosa (Eichwald)			R	P						Do.
Keyserlingia buchi (de Verneuil)			R							
Acrothele bellapunctata Walcott		N								
bergeroni Walcott							F			
bohemica (Barrande)					B					
borgholmensis Walcott		S								
ceratopygarum (Brögger)		NS								
coriacea Linnarsson		NSD								
intermedia Linnarsson	E	SD								
maculata (Davidson)	W									
primæva (de Verneuil and Barrande)									S	

Geographic distribution of European species of Cambrian Brachiopoda—Continued.

NOTE.—The letters placed opposite each species in the various columns denote the country or province in which the species occurs; for instance, in the third column an "S" indicates that the species occurs in Sweden, "SF" indicates that it occurs in both Sweden and Finland, etc.

	England, Scotland, Ireland, and Wales.	Norway, Sweden, Denmark, and Finland.	Russia and Poland.	Prussia.	Bohemia.	Bavaria.	France.	Sardinia.	Spain and Portugal.	Also occurs in—
Acrothele—Continued.										
quadrilineata Pompeckj					B					
villaboimensis Delgado									P	
sp. undt. Moberg		S								
Acrothele (Redlichella) granulata (Linnarsson)		S								
Acrotreta belti (Davidson)	EW									
carinata Segerberg		S								
circularis Moberg and Segerberg		S								
conula Walcott		S								
eggegrundensis Wiman		SF								
inchoans (Barrande)						B				
nicholsoni Davidson	E									Ordovician.
œlandica Westergård		S								
parvula (Wallerius)		S								
sabrinæ (Callaway)	E									
sagittalis (Salter)	SWI?	NSD								North America.
schmalenseei Walcott		NSD								
seebachi Walcott		NS								
socialis von Seebach		SD								
uplandica Wiman		S								
uplandica limöensis (Wiman)		S								
sp. undt. Westergård		S								
Orbiculoidea contraria (Barrande)						B				
pileolus (Salter)	W									
varians (Barrande)						B				
Nisusia? vaticina (de Verneuil and Barrande)									S	
Nisusia (Jamesella) kuthani (Pompeckj)					B					
pellico (de Verneuil and Barrande)									S	
perpasta (Pompeckj)					B					
perpasta macra (Pompeckj)					B					
perpasta subquadrata (Pompeckj)					B					
Protorthis? bunnebergensis Walcott		S								
Billingsella exporrecta (Linnarsson)		S								
exporrecta rugosicostata Walcott		S								
bicksi (Davidson)	W									
lindströmi (Linnarsson)		S								
romingeri (Barrande)					B					
Orusia lenticularis (Wahlenberg)	W	SN		P						North and South America.
Eoorthis bavarica (Barrande)		NS								
christianiæ (Kjerulf)						B				
daunus (Walcott)		NS		P						
primordialis (de Verneuil and Barrande)									S	
tullbergi (Walcott)		S								
wimani (Walcott)		NS								
sp. undt. a (Pompeckj)					B					
sp. undt. b (Pompeckj)					B					
Eostrophomena elegantula (Walcott)		S								

ASIATIC SPECIES.

Geographic distribution of Asiatic species of Cambrian Brachiopoda.

	China.	India.	Siberia.	Found also in—
Micromitra (Paterina) labradorica orientalis (Walcott)	×			
Micromitra (Iphidella) pannula ophirensis (Walcott)	(?)			North America.
Obolus chinensis (Walcott)	×			
matinalis? Walcott	×			North America.
minimus Walcott	×			
obscurus Walcott	×			
shansiensis Walcott	×			
? sp. undt. f Kayser	×			
Obolus (Westonia) blackwelderi Walcott	×			
sp. undt. a Walcott	×			
Lingulella damesi (Walcott)	×			
davisi (McCoy)	×			Europe, North America, and South America.
fuchsi Redlich		×		
kiurensis (Waagen)		×		
wanniecki Redlich		×		
Lingulella (Lingulepis) eros Walcott	×			
sp. undt. (Walcott)	×			
Neobolus warthi Waagen		×		
Dicellomus parvus Walcott	×			
Kutorgina cingulata (Billings)			×	North America.
Obolella asiatica Walcott	×			
Botsfordia granulata (Redlich)		×		
Schizopholis rugosa Waagen		×		
Yorkia? orientalis Walcott	×			
Acrothele matthewi eryx Walcott	×			
? minuta Walcott	×			
rara Walcott	×			
Discinolepis granulata Waagen		×		

Geographic distribution of Asiatic species of Cambrian Brachiopoda—Continued.

	China.	India.	Siberia.	Found also in—
Acrotreta lisani Walcott	×			
pacifica Walcott	×			
shantungensis Walcott	×			
Discinopsis? sulcatus Walcott	×			
Billingsella pumpellyi Walcott	×			
richthofeni Walcott	×			
Wynnia warthi (Waagen)		×		
Eoorthis agreste (Walcott)	×			
doris (Walcott)	×			
kayseri (Walcott)	×			
kichouensis (Walcott)	×			
linnarssoni (Kayser)	×			
pagoda (Walcott)	×			
sp. undt. Walcott	×			
Syntrophia orthia Walcott	×			
Huenella orientalis (Walcott)	×			

SOUTH AMERICAN SPECIES.

South American species of Cambrian Brachiopoda.

Obolus sp. undt. e Kayser [a]	Argentina.
Lingulella davisi (McCoy)	Do.
ferruginea Salter	Do.
Orusia lenticularis (Wahlenberg)	Do.
Eoorthis saltensis (Kayser) [a]	Do.

AUSTRALIAN SPECIES.

Australian species of Cambrian Brachiopoda.

Micromitra (Paterina) etheridgei (Tate)	South Australia.
Kutorgina peculiaris (Tate)	Do.
Obolella wirrialpensis Etheridge	Do.
Nisusia compta (Tate)	Do.
Eoorthis tatei (Etheridge)	Do.
Huenella etheridgei Walcott	Do.

ORDOVICIAN BRACHIOPODA.

NORTH AMERICAN SPECIES.

Geographic distribution of North American species of Ordovician Brachiopoda.

	General location.	Occurrence in Cambrian.[b]
Obolus anceps Walcott	Nevada	
belli (Billings)	Quebec	
cyane (Billings)	Newfoundland	
discoideus (Hall and Whitfield)	Utah	C.
dolatus (Sardeson)	Minnesota	
matinalis (Hall)	Colorado	B, C, D^2, D^4, D^5, and D^7, and China.
? murrayi Billings	Newfoundland	
rotundatus (Walcott)	Nevada	B and C.
sp. undt. a	New York	
sp. undt. c	Nevada	
Obolus (Lingulobolus) affinis (Billings)	Newfoundland and Massachusetts.	
spissus (Billings)	do	
Obolus (Westonia) elongatus Walcott	Utah	
iphis Walcott	Nevada	C.
notchensis Walcott	Utah	
rogersi Walcott	Massachusetts, Rhode Island, and Newfoundland.	
Lingulella bella (Walcott)	Newfoundland and Rhode Island.	
desiderata (Walcott)	Colorado	B, C, D^3, and D^7.
ellsi (Walcott)	Quebec	
grandis (Matthew)	New Brunswick	
iole (Billings)	Newfoundland	
irene (Billings)	Quebec	
manticula (White)	Nevada	C.
mosia (Hall)	Minnesota	D^2.
Lingulella (Lingulepis) acuminata (Conrad)	New York	B, C, D^1, D^2, D^4, D^5, and D^7.
acuminata sequens Walcott	do	

[a] Identified from South America only.

[b] See table on pp. 114–119.

Geographic distribution of North American species of Ordovician Brachiopoda—Continued.

	General location.	Occurrence in Cambrian.[a]
Elkania ambigua (Walcott)	Nevada	
desiderata (Billings)	Quebec	
ida (Billings)	do	
Dicellomus nanus (Meek and Hayden)	Wyoming	C, D^3, and D^7.
Schizambon manitouensis Walcott	Colorado	
typicalis Walcott	Nevada	C.
Acrothele levisensis Walcott	Quebec	
pretiosa (Billings)	Quebec and New York	
Linnarssonella minuta (Hall and Whitfield)	Nevada	C.
Acrotreta gemma Billings	Newfoundland	
idahoensis Walcott	Nevada	C and D^7.
ovalis Walcott	Quebec	
Billingsella coloradoensis (Shumard)	Minnesota	A, C, D^2, D^3, D^5, and D^7.
dice (Walcott)	Vermont	
Eoorthis desmopleura (Meek)	Colorado and Utah	B, C, D^6, and D^7.
desmopleura nympha (Walcott)	Colorado	D^7.
wichitaensis (Walcott)	do	C, D^3, D^4, D^5, and D^7.
Syntrophia calcifera (Billings)	Quebec and Newfoundland	
lateralis (Whitfield)	Vermont	
nundina Walcott	Nevada, Utah, and Colorado	C.
Clarkella montanensis (Walcott)	Montana	

[a] See table on pp. 114–119.

EUROPEAN SPECIES.

Geographic distribution of European species of Ordovician Brachiopoda.

	General location.	Also occurs in—
Volborthia recurva (Kutorga)	Russia	
Obolus? advenus Barrande	Bohemia	
? ancillus (Barrande)	do	
complexus Barrande	do	
feistmanteli (Barrande)	do	
? mirandus (Barrande)	do	
? rokitzanensis Barrande	do	
Obolus? (Westonia?) lamellosus (Barrande)	do	
Lingulella davidsoni (Barrande)	do	
davisi (McCoy)	England	Upper Cambrian.
heberti Barrois	Spain	
? insons (Barrande)	Bohemia	
? simplex (Barrande)	do	
Siphonotreta unguiculata (Eichwald)	Russia, and East and West Prussia.	Passage beds (Russia).
verrucosa (Eichwald)	do	Do.
Acrotreta babel Barrande	Bohemia	
? minima (Barrande)	do	
nicholsoni Davidson	Scotland and Ireland	Upper Cambrian.
subconica Kutorga	Russia	

DETAILED STRATIGRAPHIC DISTRIBUTION OF CAMBRIAN AND ORDOVICIAN BRACHIOPODA.

The following table includes, arranged alphabetically by States or countries, more or less detailed information concerning the stratigraphic distribution of the different species of Cambrian and Ordovician Brachiopoda.

The data available for the foreign species were not sufficient to warrant greater detail than that secured by the use of generalized sections, and there has been no attempt to keep the species from any one section in a distinct column. Doubtful correlations are indicated by a question mark after the locality number.

For some of the regions in North America typical fossiliferous sections have been introduced, giving in an adjoining column the species collected from the various horizons in the section and in a third column the species collected at other places in the same general area. In such tables the stratigraphic arrangement of the second column is fairly accurate; that of the third may contain errors in correlation and must be regarded as merely approximate. Each specific name is followed by the number of the locality at which it occurs, and the list of localities on pages 161–291 will furnish the student with all known information as to the association and the stratigraphic and geographic position of the species in question.

The numbers of the different localities identified from a given formation, State, country, or place may be found by referring to the index.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda.[a]

Alabama.

See Tennessee, Georgia, and Alabama, where the horizons are more or less closely differentiated and correlated, with complete lists of localities and included species.

Alberta.

See British Columbia: Mount Bosworth section, where the Alberta localities are shown in their approximate stratigraphic position.

Arizona.

One of the Arizona localities (**75**) has been assigned to the Upper Cambrian; **74b** occurs high up in the Tonto group, but has been entered as Middle Cambrian; and the remainder (see index for numbers) occur at various more or less closely related horizons in the "Tonto" sandstone.

Bohemia.

Section.	Localities and species.
ORDOVICIAN.	
Étage d4	**303m, 303n, 303o.** *Lingulella davidsoni*—303m, 303n, 303o.
LOWER ORDOVICIAN.	
Étage d3	**303, 303a, 303p.** *Lingulella? simplex*—303a, 303p. *Acrotreta babel*—303, 303a.
Étage d2	
Étage d1	**303b, 303d, 303e, 303g-l.** *Obolus? advenus*—303d. *Obolus? ancillus*—303g. *Obolus? complexus*—303g, 303h, 303i. *Obolus feistmanteli*—303i, 303j. *Obolus mirandus*—303k. *Obolus rokitzanensis*—303b. *Obolus? (Westonia?) lamellosus*—303 l. *Lingulella insons*—303d, 303e. *Lingula? eximia*—303 l. *Acrotreta? minima* 303d.
PASSAGE BEDS.	**303c, 303f.** *Obolus bavaricus*—303c. *Obolus minor*—303c. *Obolus palliatus*—303c. *Lingulella cedens*—303c, 303f. *Lingulella humillima*—303c, 303f. *Lingulella signata*—303c. *Lingulella wirthi*—303c, 303f. *Lingula* n. sp.—303f. *Acrotreta inchoans*—303c, 303f. *Acrotreta* n. sp.—303f. *Orbiculoidea contraria*—303c, 303f. *Orbiculoidea varians*—303c, 303f. *Eoorthis bavarica*—303c, 303f. (See 303f, p. 235, for associated forms other than brachiopods.)
MIDDLE CAMBRIAN.	
Étage C (see *Paradoxides* zone)	**345b?, 345c, 345f, 345g, 345h, 345 l.** *Acrothele bohemica*—345b, 345c. *Nisusia (Jamesella) kuthani*—345f. *Billingsella ramingeri*—345c, 345f, 345g, 345h, and 345 l.
Paradoxides zone (see Étage C)	**345, 345a, 345d, 345e.** *Lingulella* cf. *ferruginea*—345. *Acrothele bohemica*—345, 345a. *Acrothele quadrilineata*—345d. *Billingsella ramingeri*—345. *Eoorthis* sp. undt. a—345. *Eoorthis* sp. undt. b—345e. (See 345, p. 270, for additional forms.)
LOWER CAMBRIAN.	
Conglomerate zone of the Kamenná hůrka	**345l, 345j, 345k?.** *Nisusia (Jamesella) kuthani*—345i, 345j, 345k. *Nisusia (Jamesella) perpasta*—345i, 345j, 345k. *Nisusia (Jamesella) perpasta macra*—345i, 345j. *Nisusia (Jamesella) perpasta subquadrata*—345i, 345j.

[a] For complete lists of the localities in each State, country, formation, etc., see index.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

British Columbia: Mount Bosworth.

Mount Bosworth section. [Walcott, 1908f, pp. 204–217.]		Localities and species in the Mount Bosworth section.	Other localities and species in British Columbia and Alberta shown in their approximate stratigraphic position.
The Mount Bosworth section is exposed north of Hector, British Columbia, on the Continental Divide north of the Canadian Pacific Railway. The general dip of the strata is to the northwest 20°; strike, N. 30° E. The section is continuous except for the displacement between the Paget and Bosworth formations of the Upper Cambrian. That this does not cut out any considerable thickness of strata is proved by the unbroken section in the cliffs of Mount Daly 3 miles to the north. Only the upper part of the St. Piran sandstone is exposed on Mount Bosworth; the remainder of the section shown on pages 131 and 132 was measured in the vicinity of lakes Louise and Agnes, nearly 5 miles to the southeast. The summit of the section is on the west spur (Sherbrooke ridge) of Mount Bosworth overlooking Sherbrooke Lake. The highest beds are on the south summit of the ridge, and from their lithologic character and the presence of obscure fossils that suggest *Ophileta* of the Lower Ordovician the upper 110 feet of strata is tentatively referred to the Ordovician system.[a] The strata near the summit are much broken up owing to a fault line that crosses the ridge.			
ORDOVICIAN.[a]			
1. Massive-bedded gray and bluish-gray arenaceous limestone, with thin layers, irregular stringers, and nodules of dark chert.....	*Feet.* 110		
UPPER CAMBRIAN.			
Sherbrooke limestone [Walcott, 1908a, p. 2]: 1. Massive-bedded bluish-gray limestone, with some cherty matter in the form of small nodules and stringers; also irregular partings and fillings of annelid borings by gray dolomitic limestone, weathering buff.....	175	Annelid borings and trails. Fragments of undeterminable trilobites.	
2*a*. Gray oolitic limestone in thick layers, with bluish banded limestone intercalated at irregular intervals. The banded appearance of the nonoolitic layers is owing to the buff-weathering of the thin dolomitic layers..... 190		*Crepicephalus.* *Pterocephalia?.* *Ptychoparia.*	
2*b*. Greenish-drab and gray siliceous shales with interbedded oolitic limestone in bands of layers from 6 inches to 4 feet thick; also a few bands of thick-bedded bluish-gray limestone that breaks up into shaly limestone on weathering.. 335		**57d, 58f.** In green shales near summit: *Lingulella isse*—57d. In oolitic layers: *Agnostus* sp. undt. *Illænurus.* *Ptychoparia.* In limestone: *Obolus* sp.—58f.	
2*c*. Gray oolitic limestone with thin bands of interbedded shaly blue-gray limestone. Gray dolomitic buff-weathering flattened nodules, stringers, and thin layers of limestone occur in a very irregular manner..... 65	590	*Illænurus.* *Agnostus.* *Ptychoparia.* *Bathyurus*-like pygidia.	
3. Arenaceous dolomitic steel-gray limestone, weathering light gray and buff gray.....	610		
The line of demarcation between 3 and the bluish-gray limestones below is irregular. The gray beds of 3 extend along the cliff and abruptly change to bluish gray. In the upper 100 feet of 3 irregular masses of bluish-gray limestone occur like great lentiles, as though they were cores left in the general alteration (dolomitization) of the strata.			
Total of Sherbrooke limestone.....	1,375		
Paget limestone [Walcott, 1908a, p. 3]: 1. Massive-bedded dark bluish-gray limestone forming base of cliff on the west side of the amphitheater on the west slope of Mount Bosworth and, with 3 of Sherbrooke limestone, the upper cliffs of Paget Peak and Mount Daly.....	60		
2. Massive beds of oolitic limestone with irregular interbedded bands of green siliceous shale. Thin layers, irregular stringers, and nodules of gray buff-weathering dolomite occur in the oolitic limestones.....	300+	*Hyolithes.* *Agnostus.* *Crepicephalus.*	
Base covered by talus slope on line of the section. It is well exposed on the southeast face of Mount Daly and Paget Peak. The thickness is placed at 300 feet, which I think is less than the total thickness. Over 200 feet was measured.			
Total of Paget limestone.....	360+		

[a] During the field season of 1911 these beds were examined by Mr. J. A. Allan and Mr. L. D. Burling, who found, in the uppermost portion, fossils similar to those in 2*b* of the Sherbrooke limestone. This made it possible to place between the new Sherbrooke and the true Ordovician a series of nearly 4,000 feet of Upper Cambrian shales and limestones referred by Mr. Allan to the Chancellor and Ottertail formations, respectively. (See Walcott, 1912, Smithsonian Miscellaneous Collections, vol. 57, No. 7, pp. 229–231.)

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

British Columbia: Mount Bosworth—Continued.

Mount Bosworth section. [Walcott, 1908f, pp. 204–217.]			Localities and species in the Mount Bosworth section.	Other localities and species in British Columbia and Alberta shown in their approximate stratigraphic position.
UPPER CAMBRIAN—continued.				
Bosworth formation [Walcott, 1908a, p. 3]:[a]				
1. Massive-bedded gray and bluish-gray arenaceous dolomitic limestone. Several bands of steel-gray, yellowish buff-weathering bands of strata occur in the lower half of 1. This formation forms the base of the high cliffs on the southeast face of Mount Daly and Paget Peak. The lower portion of 1 was measured and the upper parts estimated. The thickness given is probably 100 feet or more less than the actual thickness.		*Feet.* 600+		
2*a*. Shaly and thin-bedded gray and dove-colored, compact, fine-grained dolomitic limestone weathering buff and light gray. Thicker layers occur in bands from 1 to 6 feet thick	422			
2*b*. Greenish siliceous shale with thin interbedded layers of siliceous, compact, gray limestone	48			At about this horizon in the Castle Mountain section, 20 miles southeast of Mount Bosworth, small trilobite heads of the genera *Ptychoparia* and *Solenopleura* occur in a band of gray and bluish-black limestone, and, just below, fragments of a species of *Obolus*.
2*c*. Limestones similar to 2*a*	517			
		987		
3. Variable arenaceous shales with alternating bands of color—greenish, deep red, buff, yellow, and gray. Numerous mud cracks and ripple-marks occur on many of the layers.	268			
Total of Bosworth formation		1,855+		
Total Upper Cambrian		3,590+		
MIDDLE CAMBRIAN.				
Eldon limestone [Walcott, 1908a, p. 3]:				
1*a*. Irregularly bedded gray siliceous and arenaceous limestone in thick layers above and thin layers below; at 192 feet from the base a bed of bluish-black limestone is fossiliferous. Above the fossiliferous bed the strata become more massive, arenaceous, steel gray in color, and weather to a light gray	410		192 feet above the base: *Agnostus* sp. *Ptychoparia*, 2 species. *Bathyuriscus*-like pygidium.	
1*b*. Light and dark gray thin-bedded arenaceous limestone weathering light gray	110			
1*c*. Massive-bedded siliceous, fine-grained, compact, dark bluish-gray limestone. Two yellowish buff-weathering bands of limestone 2 to 3 feet thick stand out in color on the face of cliffs.	197		Near the summit: *Billingsella?* *Nolenus*-like pygidium.	
1*d*. Massive-bedded limestone much like that of 1c	71			
		788		
2. Thin-bedded bluish-gray limestone with irregular layers and stringers of gray buff-weathering dolomitic limestone. At 24 feet from the base a shaly bluish-gray siliceous limestone about 2 feet thick is interbedded.	95		**35g.** In shaly limestone: *Obolus meconnelli* var.—35g. *Obolus membranaceus*—35g. *Isorys* cf. *argentea*—35g. *Ptychoparia*, 3 species—35g.	
3. Massive-bedded dark-gray arenaceous limestone	190			

[a] This formation reminds me, in lithologic character and appearance, of strata of the upper portions of the Algonkian Belt series of Montana. No traces of life were observed and the shaly, banded character of the beds is very striking.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

British Columbia: Mount Bosworth—Continued.

Mount Bosworth section. [Walcott, 1908f, pp. 204–217.]		Localities and species in the Mount Bosworth section.	Other localities and species in British Columbia and Alberta shown in their approximate stratigraphic position.
MIDDLE CAMBRIAN—continued.			
Eldon limestone—Continued.			
4. Massive-bedded cliff-forming light-gray arenaceous limestone. At several horizons bands of thinner layers from a few feet up to 30 feet in thickness occur. One of these 480 feet from the base forms a slight terrace	*Feet.* 1,655		**57n.** In the Mount Stephen section, 7 miles southwest of Mount Bosworth, at a horizon about 700 feet above the base of this limestone, the following fossils have been recognized: *Protospongia* (spicules)—57n. *Lingulella* cf. *isse*—57n. *Hyolithes* sp.—57n. *Agnostus* cf. *montis*—57n. *Zacanthoides spinosus*—57n. *Ptychoparia* sp.—57n. *Bathyuriscus* sp.—57n. *Ogygopsis* sp.—57n.
Total of Eldon limestone	2,728		
Stephen formation [Walcott, 1908a, p. 3]: 1. Thin-bedded dark-gray and bluish-black limestone	315	**57c, 57k.** *Micromitra zenobia*—57c. *Obolus mcconnelli*—57c, 57k. *Nisusia alberta* var.—57c, 57k. *Hyolithes carinatus*—57c. *Agnostus* sp.—57k. *Agraulos* sp.—57k. *Menocephalus* sp.—57c. *Ptychoparia*, 3 species—57c, 57k. *Neolenus* sp.—57c, 57k. *Bathyuriscus* sp.—57c.	**35k,**[a] **57f, 57j, 58i, 58j, 58r, 58w.** *Micromitra zenobia*—35k. *Micromitra (Paterina) stissingensis ora*—35k. *Micromitra (Iphidella) pannula*—35k, 57j. *Obolus mcconnelli*—57f, 58i, 58j, 58r, 58w. *Acrothele subsidua*—58j. *Acrotreta depressa*—57f, 58j, 58r. *Nisusia alberta*—35k, 57j. *Nisusia (Jamesella)* cf. *nautes*—57f. (See 35k, 57f, 57j, 58j, and 58r, pp. 198 and 207–210, for additional associated forms.)
			14s. At Mount Stephen, about 7 miles southwest of Mount Bosworth, a siliceous shale[b] occurs at the summit of the Stephen formation, in which the following unusually rich fauna occurs: *Hyolithellus flagellum* (Matthew) [1899, p. 40]. *Hyolithellus annulatus* (Matthew) [1899, p. 42]. *Orthotheca corrugata* Matthew [1899, p. 42]. *Orthotheca major* Walcott [1908c, p. 246, Pl. I, fig. 11]. *Hyolithes carinatus* Matthew [1899, p. 42]. *Hyolithes* sp. *Stenotheca wheeleri* Walcott [1908c, p. 245, Pl. I, fig. 7]. *Platyceras rominger* Walcott [1889c, p. 442]. *Platyceras bellianus* Walcott [1908c, p. 246, Pl. I, fig. 13]. *Acrotreta depressa* (Walcott) [1889c, p. 441]. *Micromitra (Iphidella) pannula* (White) [1874, p. 6]. *Obolus mcconnelli* (Walcott) [1889c, p. 441]. *Obolus septalis* Walcott [1905a, p. 331]. *Nisusia alberta* Walcott [1889c, p. 442]. *Philhedra columbiana* (Walcott) [1889c, p. 441]. *Scenella varians* Walcott [1886b, p. 127].

[a] This is the locality containing the beautifully preserved annelids, medusæ, holothurians, crustaceans, etc., now being described and illustrated in volume 57 of the Smithsonian Miscellaneous Collections.

[b] The name *Ogygopsis* zone is applied to the local development of arenaceous and calcareous shale at the summit of the Stephen formation on the northwestslope of Mount Stephen. The shale band (lentile) has a maximum thickness of about 150 feet. It thins out to the northeast and is faulted out to the southwest. At its maximum thickness, 2,800 feet above Field, it carries immense numbers of trilobites, especially *Ogygopsis klotzi* (Rominger), *Bathyuriscus rotundatus* (Rominger), *Neolenus serratus* (Rominger), *Zacanthoides spinosus* (Walcott), and, in addition, sponges, cystids, brachiopods, pteropods, and gastropods. The shale is less rich in fossils one-fourth mile northeast on the strike; also to the northwest. Lentiles of gray quartzitic sandstone and siliceous gray limestone occur in the shale, and the entire band appears to be a lentile between the thin-bedded blue limestones and the superjacent massive arenaceous limestone formation. There is no trace of the *Ogygopsis* zone at the same horizon on Castle Mountain 20 miles east-southeast. On Mount Field it is represented by the Burgess shale, Locality 35k.

There is a sharp anticline, with a northeast-southwest axis, in the shale and the thin-bedded limestones beneath, on the northwest slope of Mount Stephen. The southeast limb is crushed and the beds are largely faulted out against the massive arenaceous limestone before reaching the amphitheater at the head of Field Brook. On the northwest limb the shales are unaltered and slope down the side of the mountain for 1,800 feet, thus affording a great exposure of the shale and contained fossils.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

British Columbia: Mount Bosworth—Continued.

Mount Bosworth section. [Walcott, 1908f, pp. 204–217.]		Localities and species in the Mount Bosworth section.	Other localities and species in British Columbia and Alberta shown in their approximate stratigraphic position.
MIDDLE CAMBRIAN—continued.			
Stephen formation—Continued.			14s—Continued. *Anomalocaris canadensis* Whiteaves [1892, p. 207]. *Anomalocaris? whiteavesi* Walcott [1908c, p. 246, Pl. II, figs. 2, 2a, 4, 6, and 6a]. *Anomalocaris?? acutangula* Walcott [1908c, p. 247, Pl. II, fig. 5]. *Agnostus montis* Matthew [1899, p. 43]. *Dorypyge* (*Kootenia*) *dawsoni* (Walcott) [1889c, p. 446]. *Bathyuriscus rotundatus* (Rominger) [1887, p. 16]. *Bathyuriscus pupa* Matthew [1899, p. 51] probably= *Bathyuriscus occidentalis*. *Bathyuriscus occidentalis* (Matthew) [1899, p. 49]. *Bathyuriscus ornatus* Walcott [1908b, p. 39]. *Karlia stephenensis* Walcott [1889c, p. 445]. *Corynexochus romingeri* Matthew [1899, p. 47]=*Karlia stephenensis*. *Neolenus serratus* (Rominger) [1887, p. 13]. *Neolenus granulatus* Matthew [1899, p. 55]= *Neolenus serratus*. *Ogygopsis klotzi* (Rominger) [1887, p. 12]. *Oryctocephalus reynoldsi* Reed [1899, p. 359]. *Oryctocephalus walkeri* Matthew [1899]= *Oryctocephalus reynoldsi*. *Burlingia hectori* Walcott [1908b, p. 15]. *Ptychoparia cordilleræ* (Rominger) [1887, p. 17]. *Conocephalites* cf. *perseus* Hall, Matthew [1899, p. 46] = *Ptychoparia cordilleræ*. *Ptychoparia palliseri* Walcott [1908c, p. 247, Pl. III, fig. 6]. *Zacanthoides spinosus* (Walcott) [1884, p. 63].
2a. Greenish siliceous shale	*Feet.* 23	**57y.** *Obolus* (*Westonia*) *ella?*—57y.	
2b. Thick-bedded bluish-gray limestone, breaking up into thin layers ½ to 3 inches thick on weathering	22	**58z.** *Micromitra zenobia*—58z. *Nisusia alberta* var.—58z. *Menocephalus*—58z. *Ptychoparia*—58z. *Neolenus*—58z.	
2c. Greenish siliceous shale	70		
2d. Alternating bluish-gray bedded compact limestone, siliceous and arenaceous shale, mostly shale below	210	**57g.** *Cruziana*. *Micromitra* (*Iphidella*) *pannula*—57g. *Obolus* (*Westonia*) *ella*—57g. *Hyolithes*—57g. *Leperditia*—57g. *Ptychoparia*—57g. *Bathyuriscus*—57g.	**58 l.** On Mount Stephen, at a horizon 150 feet from the base of this limestone, the fauna includes: *Micromitra zenobia*—58 l. *Lingulella desiderata*—58 l. *Billingsella marion*—58 l. *Hyolithes*—58 l. *Microdiscus*—58 l. *Ptychoparia*—58 l.
	325		
Total of Stephen formation	640		
Cathedral limestone [Walcott, 1908a, p. 4]: 1a. Thin-bedded gray to lead-gray arenaceous limestones, weathering buff gray to dull light gray	404		
1b. Massive-bedded steel-gray weathering light-gray arenaceous limestone. In some localities thinner layers appear at various horizons and large lentiles of dark lead-gray colored beds occur very irregularly	682		

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

British Columbia: Mount Bosworth—Continued.

Mount Bosworth section. [Walcott, 1908f, pp. 204–217.]		Localities and species in the Mount Bosworth section.	Other localities and species in British Columbia and Alberta shown in their approximate stratigraphic position.
MIDDLE CAMBRIAN—continued.			
Cathedral limestone—Continued.	*Feet.*		
1*c*. Similar to 1*a*. Annelid borings and trails occur in and on some of the layers	126		
1*d*. Similar to 1*b*	83		
1*e*. Thin-bedded lead-gray to blue-gray thin-bedded (layers 1 inch to 4 inches thick) arenaceous limestone	25		
1*f*. Alternating thin and massive bedded arenaceous steel-gray limestone weathering light gray	275		
	1,595		
Total Middle Cambrian	4,963		
LOWER CAMBRIAN.			
Mount Whyte formation [Walcott, 1908a, p. 4]: The line between the Middle and Lower Cambrian is placed at this horizon on account of the presence in the Mount Stephen section of *Olenellus* in the limestone 116 feet below the massive arenaceous limestone belt represented by 1*f* in the Cathedral limestone of the Mount Bosworth section.			
1*a*. Thin-bedded bluish-gray slightly arenaceous limestone	120	Numerous annelid trails and borings.	
1*b*. Gray oolitic limestone in layers 3 to 6 inches thick	44	**57s.** *Acrotreta sagittalis taconica*—57s. *Nisusia* (*Jamesella*) *lowi*—57s. *Micradiscus* sp. undt.—57s. *Agraulos* sp.—57s. *Ptychoparia* sp.—57s.	**57m, 58k, 58p, 58t.** In the Mount Stephen section the following species occur at a horizon near the top of this limestone (**58k** and **58p**): *Acrotreta sagittalis taconica*—58k. *Nisusia alberta* var.—58k, 58p. *Nisusia* (*Jamesella*) *lowi*—58k, 58p. *Stenotheca elongata* var.—58k. *Scenella varians*—58k. *Platyceras* n. sp.—58k. *Hyolithes billingsi*—58k, 58p. *Ptychoparia* sp.—58k, 58p *Crepicephalus* n. sp.—58k. *Protypus* n. sp.—58k. *Albertella* sp. undt.—58k. At Castle Mountain *Obolus parvus* occurs at about this horizon (**58t**). About 50 feet down in the Mount Stephen section, in a gray siliceous shale, the following species occur (**57m**): Cystid plates—57m. *Micromitra* (*Paterina*) sp. undt.—57m. *Acrotreta sagittalis taconica*—57m. *Nisusia* (*Jamesella*) *lowi*—57m. *Hyolithes* (fragment)—57m. *Hyolithellus* cf. *micans*—57m. *Scenella varians*—57m. *Olenellus canadensis*—57m.
1*c*. Massive layers made up of banded bluish-gray limestone and sandstone in layers ½ inch to 2 inches thick	60	*Agraulos* sp. undt.	**57e, 57r, 58s.** On Mount Stephen, at a horizon near the top of this bed of limestone, there was found (**57e**): *Acrothele colleni*—57e. *Acrotreta sagittalis taconica*—57e. *Scenella varians*—57e. *Stenotheca elongata* var.—57e. *Albertella* sp. undt.—57e. *Olenellus canadensis*—57e. *Bathyuriscus* sp. undt.—57e. Near the base on Mount Stephen (**57r, 58s**): *Micromitra* (*Paterina*) *labradorica* var.—57r, 58s. *Micromitra* (*Iphidella*) *pannula*—57r, 58s. *Acrotreta sagittalis taconica*—57r, 58s. *Ptychoparia*, 3 species—57r, 58s.
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Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

British Columbia: Mount Bosworth—Continued.

Mount Bosworth section. [Walcott, 1908f, pp. 204–217.]		Localities and species in the Mount Bosworth section.	Other localities and species in British Columbia and Alberta shown in their approximate stratigraphic position.
LOWER CAMBRIAN—continued.			
Mount Whyte formation—Continued.	*Feet.*		
2. Gray and brownish-gray sandstone in thin and massive layers	31	*Hyolithes.* *Agraulos.*	On Mount Stephen, at this horizon, there were found: *Microdiscus* sp. undt. *Olenellus* sp. undt. (fragments). *Ptychoparia* sp. undt. *Protypus* sp. undt.
3. Siliceous shale with a few interbedded thin layers of compact hard gray sandstone	115	**35c.** On the south slope of Mount Bosworth two drift blocks of siliceous shale, supposed to be from this horizon, were found, from which the following species were collected: *Micromitra* (*Paterina*) *wapta*—35c. *Obolus parvus*—35c. *Acrothele colleni*—35c. *Wimanella simplex*—35c. *Agraulos* sp.—35c. *Ptychoparia* sp.—35c. *Albertella bosworthi*—35c. *Albertella helena*—35c. *Bathyuriscus* sp.—35c.	**35e.** In the Lake Agnes section, 5 miles southeast of Mount Bosworth, the fauna of about this horizon includes: *Micromitra* (*Paterina*) *wapta*—35e. *Obolus parvus*—35e. *Hyolithes billingsi*—35e. *Olenopsis* n. sp.—35e. *Ptychoparia*, 3 species.—35e. *Albertella* sp. undt.—35e. *Bathyuriscus*—35e. *Olenellus gilberti*—35e. On Mount Stephen, at about the same horizon, the following were found: *Hyolithes billingsi.* *Scenella varians.* *Olenopsis* n. sp.
4. Interbedded layers of gray fossiliferous limestone and greenish-gray siliceous shale	20	**35h.** *Nisusia festinata*—35h. *Scenella varians*—35h. *Hyolithellus*—35h. *Ptychoparia*—35h. *Agraulos*—35h. *Protypus* n. sp.—35h. *Olenellus canadensis*—35h. *Olenellus gilberti*—35h.	**35f.** At this horizon on Mount Stephen the following were found: *Micromitra* (*Iphidella*) *pannula*—35f. *Kutorgina cingulata*—35f. *Kutorgina* sp. undt.—35f. *Acrotreta sagittalis taconica*—35f. *Nisusia festinata*—35f. *Hyolithes billingsi*—35f. *Scenella varians*—35f. *Protypus* n. sp.—35f. *Agraulos* sp. undt.—35f. *Ptychoparia*, 3 sp. undt.—35f. *Olenellus canadensis*—35f.
Total of Mount Whyte formation	390		
Bow River group.			
St. Piran sandstone [Walcott, 1908a, p. 4]:			
1a. Siliceous and arenaceous greenish-colored shales in layers 1 to 3 inches in thickness interbedded in shaly and thin-bedded gray and brownish-gray sandstone, with a thick layer of compact gray sandstone near the top	68		
1b. Irregularly bedded brownish, dirty-gray, and occasionally purplish-colored sandstones, more or less compact and quartzitic, in massive and thin layers that break down readily on slopes	310	Annelid trails and borings (*Scolithus*). *Hyolithes.* *Olenellus canadensis?.* *Ptychoparia*, 2 species.	**60b.** *Obolella vermilionensis*—60b. *Wanneria gracile*—60b.
1c. Massive-bedded compact light-gray and pinkish quartzitic sandstones	125	Annelid trails and borings (*Scolithus*). *Hyolithes.* *Olenellus canadensis?.*	
	503		
In the Lakes Louise and Agnes section, about 5 miles southeast of Mount Bosworth, the total thickness of the St. Piran sandstone is	2,705		
Below the St. Piran the following section occurs:			
Lake Louise shale [Walcott, 1908a, p. 5]:			
1. Compact gray siliceous shale	105	**35d.** Annelid trails—35d. *Cruziana*—35d. *Micromitra* (*Iphidella*) *louise*—35d.	

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

British Columbia: Mount Bosworth—Continued.

Mount Bosworth section. [Walcott, 1908f, pp. 204–217.]		Localities and species in the Mount Bosworth section.	Other localities and species in British Columbia and Alberta shown in their approximate stratigraphic position.
LOWER CAMBRIAN—continued.			
Bow River group—Continued.			
Fort Mountain sandstone:[a]			
1. Thin and thick layers of gray, quartzitic, brownish weathering, compact sandstones (estimated)	*Feet.* 600+		
Total Lower Cambrian	3,800+		
Total Cambrian	12,353+		

[a] In 1908 [Walcott, 1908a, p. 5] these quartzitic sandstones were described as the "Fairview formation." As that name, however, is preoccupied in American nomenclature, and as the lower part of the formation has since been found exposed at several places on the east side of the Bow River Valley, it has been decided to apply the name Fort Mountain sandstone to the whole, from the typical exposures on Fort Mountain. The formation is here composed of 2,700 feet of sandstones similar to the 600 feet of sediments to which the name "Fairview" was applied, and a basal bed of massive conglomerate nearly 200 feet thick. At this locality the Fort Mountain formation is unconformably underlain by pre-Cambrian rocks.

California.

See Nevada, Barrel Spring section, where the California localities are shown in their approximate stratigraphic position.

Cape Breton and New Brunswick.

For the strata above the Etcheminian a generalized section only has been used. The Cape Breton localities have, however, been kept distinct from those in the vicinity of St. John. The Acadian is not represented in the brachiopod collections from Cape Breton. The Etcheminian is so well developed and so fossiliferous on Dugald Brook that Matthew's section is copied and the fossils from the brook are kept separate from those occurring elsewhere.

Section.	Localities and species occurring in Cape Breton arranged in their approximate stratigraphic position.	Localities and species occurring in the vicinity of St. John, New Brunswick, arranged in their approximate stratigraphic position.
UPPER CAMBRIAN. *Bretonian* [Matthew, 1903, pp. 49 and 240]: Division C3c2 (*Asaphellus* zone).	**307a.** *Lingulella* cf. *davisi*—307a. *Lingulella ferruginea*—307a. *Lingulella* cf. *lepis*—307a. *Acrotreta bisecta*—307a. (See 307a, p. 238, for additional associated forms.)	
Division C3c (*Dictyonema* zone).	**3h, 3o-q, 8d, 10c-i, 10k-n, 13h, 16o, 307, 372, 372a-e.** *Obolus acadicus*—3h. *Obolus refulgens*—307, 372e. *Obolus (Bröggeria) salteri*—3h, 3q, 10c, 10d, 10e, 10g, 10i, 10l, 10m, 10n, 13h. *Lingulella concinna*—3h, 3o, 3p, 3q, 8d, 10c, 10e–h, 10i, 10l, 10n, 13h, 16o, 307, 372, 372a–d. *Lingulella ferruginea*—3h, 307. *Acrothele* sp.—10f, 10h. *Acrotreta* cf. *belti*—307. *Acrotreta bisecta*—3q, 10c, 10d–g, 10l, 10n, 13h. *Acrotreta convexa*—10e, 10i. *Schizambon priscus*—3q, 10c–i, 10k, 10l, 13h, 307, 372e. *Orusia lenticularis*—10h.	**308.** *Obolus refulgens*—308. *Lingulella ferruginea*—308. *Schizambon priscus*—308. *Acrotreta bisecta*—308. *Acrotreta belti?*—308.
Division C3b (*Peltura* zone).	**3n?, 13q, 307e?, 307h?, 307i, 307j?, 325?.** *Obolus (Westonia) escasoni*—325. *Lingulella minor*—3n. *Lingulella (Lingulepis) exigua*—3n. *Acrotreta convexa*—3n. *Orusia lenticularis*—13q, 307e, 307h–j. (See 13q, 307i, 307j, and 325, pp. 183, 239, 240, and 259, for additional associated forms.)	**2x?, 301u.** *Lingulella* cf. *lepis*—301u. *Sphærophthalmus alatus*—301u. *Lingulella minor*—2x. *Lingulella minor?*—2x. *Lingulella (Lingulepis) starri*—2x.
Division C3a (*Parabolina* zone).	**10r, 325b.** *Obolus (Bröggeria) salteri*—10r. *Obolus (Palæobolus) bretonensis*—10r. *Obolus (Westonia) escasoni?*—10r. *Lingulella lævis grandis*—325b. *Lingulella lens*—10r.	**301e, 301n, 301t, 308a, 308b, 308f.** *Lingulella lævis*—301n. *Lingulella lævis grandis*—301t. *Lingulella* cf. *lepis*—301e. *Orusia lenticularis*—308b, 308f. *Orusia lenticularis atrypoides*—308h. *Orusia lenticularis lyncioides*—308b. *Eoorthis atava*—308a. *Eoorthis johannensis*—308b. (See 308b and 308f, p. 239, for additional associated forms.)
MIDDLE CAMBRIAN. *Johannian* [Matthew, 1903, pp. 40 and 240]: Division C2c.	**307b?, 307c, 325a.** *Lingulella flumenis*—325a. *Lingulella radula*—307b, 307c. *Lingulella rotundata*—325a. *Acrotreta* sp. undt.—325a.	**301x, 301y.** *Lingulella radula*—301x, 301y.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Cape Breton and New Brunswick—Continued.

Section.	Localities and species occurring in Cape Breton arranged in their approximate stratigraphic position.	Localities and species occurring in the vicinity of St. John, New Brunswick, arranged in their approximate stratigraphic position.
MIDDLE CAMBRIAN—continued.		
Johannian—Continued. Division C2b (*Forchhammeri* zone).	**3i, 10o??, 10s?, 10t?, 11z??, 13l, 13r, 307g, 325c?** *Obolus (Westonia) cascasoni?*—10o, 11z. *Lingulella cania*—3i, 10s. *Lingulella concinna*—3i. *Lingulella ferruginea*—3i. *Lingulella rotundata*—3i, 325c. *Lingulella tumida*—13i, 13r. *Lingulella (Lingulepis) exigua*—3i, 10s, 10t, 11z, 13i, 13r, 307g. *Acrothyra proavia*—3i. (See 10s and 307g, pp. 177 and 238, for additional associated forms.)	**308c.** *Lingulella (Lingulepis) starri.*—308c.
Division C2a.	**307f.** *Lingulella (Lingulepis) exigua*—307f.	
Acadian [Matthew, 1903, pp. 39 and 240]:[a] Division C1d.		**300, 301l.** *Lingulella ferruginea*—301l. *Acrothele matthewi*—301l. *Acrothele prima costata*—301l. *Acrotreta baileyi*—300. *Acrotreta miscra*—301l. (See both 300 and 301l, pp. 229 and 231, for additional associated forms.)
Division C1c.		**2e?, 2i?, 2m?, 2s, 2t, 3b?, 301g, 301h, 301j, 301k, 301m, 301w** (from 1c2), **301z, 308h** (from 1c1), **308i.** *Lingulella ferruginea*—2l, 2s, 301g, 301h, 301k, 301z. *Acrothele matthewi*—2l, 2s, 3h, 301g, 301h, 301j, 301k, 301w, 301z, 308h. *Acrothele matthewi lata*—301g. *Acrothele matthewi multicostata*—2l, 2s, 2t. *Acrotreta gracia*—2s. *Acrotreta miscra*—2s, 2t. *Acrotreta sagittalis*—2s. *Acrotreta sagittalis magna*—2l, 2s. *Acrotreta sagittalis transversa*—301k. *Discinopsis gulielmi*—301g, 301w, 308h. *Billingsella coloradoensis*—2s. *Billingsella* sp.—2s. *Protorthis billingsi*—2e, 2l, 3b, 301g, 301j, 301k, 308h, 308i. *Protorthis latourensis*—301g, 301w, 308h. *Protorthis quacoensis*—3b, 301g, 301m, 301w. *Eoorthis hastingsensis*—2l, 2s. (See 301g, 301h, 301k, 301m, 301w, 301z, 308h, and 308i, pp. 230–232 and 239, for additional associated forms.)
Division C1b5.		**301h, 301d, 301f.** *Acrothele prima costata*—301d, 301f. *Acrotreta sagittalis transversa*—301h.
Division C1b4.		**308d.** *Botsfordia pulchra.*
Division C1b3.		**2i, 2k, 2u?, 301a, 301c?, 308d, 308g** (may belong with 1b4). *Lingulella ferruginea?*—2i. *Lingulella martinensis*—2i. *Botsfordia pulchra*—308d. *Botsfordia* sp.—2i. *Acrothele matthewi lata*—301a. *Acrothele matthewi prima*—301a. *Acrothele prima*—2i. *Acrothele prima costata*—2i, 2k. *Acrotreta gemmula*—301a. *Acrotreta sagittalis magna*—2i. *Acrotreta sagittalis transversa*—2i, 2k, 301c. *Acrotreta* sp.—301c. *Trematobolus kempanum*—2u, 308g. *Trematobolus pristinus*—2i, 2k. *Protorthis helena*—2u. *Protorthis (Loperia) dugaldensis*—2u. (See 2k and 301a, pp. 163 and 230, for additional associated forms.)

[a] The *Protolenus* zone of Matthew in New Brunswick corresponds in large part with the Acadian.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Cape Breton and New Brunswick—Continued.

Section.	Localities and species occurring in Cape Breton arranged in their approximate stratigraphic position.	Localities and species occurring in the vicinity of St. John, New Brunswick, arranged in their approximate stratigraphic position.
MIDDLE CAMBRIAN—continued. *Acadian*—Continued. Division C1b2.		**2h, 301, 308d.** *Lingulella martinensis*—2h. *Acrothele matthewi lata*—301. *Acrothele prima*—2h. *Acrothele prima costata*—2h. *Acrotreta baileyi*—301. *Acrotreta gemmula*—301. *Acrotreta sagittalis transversa*—2h. *Botsfordia pulchra*—308d. *Trematobolus insignis*—301. *Trematobolus pristinus*—2h, 301. (See 2h and 301, pp. 162 and 229, for additional associated forms.)
Division C1b1.		**2f, 2g, 2y?, 301i, 308e.** *Lingulella martinensis*—2f, 2g. *Acrothele matthewi*—301i. *Acrothele prima*—2f. *Acrotreta inflata*—2f, 2g. *Acrotreta sagittalis*—2g. *Acrotreta sagittalis transversa*—2f, 2g. *Botsfordia cælata*—308e. *Botsfordia pulchra*—2y. (See 2g, p. 162, for additional associated forms.)

Dugald Brook section. [Matthew, 1903, pp. 21–25.]	Localities and species occurring in the Dugald Brook section.	Localities and species occurring elsewhere in Cape Breton shown in their approximate stratigraphic position.
Etcheminian: Division E3f. *Feet.* Siliceous gray shale..... 10 Dark-gray rather coarse shales..... 32 Dark-gray somewhat siliceous flaggy shales..... 40	13n, **344d.** *Lingulella atava*—13n, 344d. *Lingulella collicia*—344d. *Acrothele avia*—13n. *Acrothele proles*—13n, 344d. *Acrothyra proavia*—**344d.** (See 13n and 344d, pp. 182 and 269, for additional associated forms.)	**13m.** *Obolus (Palæobolus) bretonensis lens*—13m. *Lingulella collicia*—13m. *Acrothele avia*—13m. *Acrothele avia putcis*—13m. *Acrothele proles*—13m. *Acrothyra proavia*—13m. (See 13m, p. 182, for additional associated forms.)
Division E3e. Dark-gray shale, alternately harder and softer..... 18	**13n′.** *Obolus (Palæobolus) bretonensis lens*—13n′. *Lingulella atava*—13n′. *Lingulella collicia*—13n′. *Lingulella tumida*—13n′. *Acrothele avia*—13n′. *Acrothyra proavia*—13n′. (See 13n′, p. 182, for additional associated species.)	**344j.** *Acrothyra proavia*—344j.
Division E3d. Dark-gray and some purplish-gray shale..... 30	**13n″, 344b.** *Obolus (Palæobolus) bretonensis*—13n″, 344b. *Lingulella atava*—13n″, 344b. *Acrothele avia*—344b. *Acrothyra proavia*—13n″, 344b. (See 13n″ and 344b, pp. 183 and 268, for additional associated forms.)	**344c.** *Obolus (Palæobolus) bretonensis*—344c. *Acrothele avia putcis*—344c.
Division E3c. Gray argillaceous sandstone. 25	**344a.** *Lingulella collicia*—344a. *Lingulella* sp.—344a. *Acrothele avia*—344a. *Acrotreta* sp.—344a. *Acrothyra proavia*—344a. (See 344a, p. 268, for additional associated forms.)	
Division E3b. Fine gray shale..... 25	**344.** *Obolus (Palæobolus) bretonensis*—344. *Lingulella atava*—344. *Lingulella* sp.—344. *Acrothele avia*—344.	
Division E3a. Dark-gray feldspathic sandstones, having seams of gray grit with felsite débris..... 50 Gray micaceous shale..... 4 —— 234	**13l, 13l′, 344i.** *Obolus (Palæobolus) bretonensis*—13l′, 344i. *Obolus (Palæobolus) bretonensis lens*—13l, 344i. *Lingulella atava*—13l′. *Acrothele avia*—13l, 13l′, 344i. *Acrothele proles*—13l, 13l′. *Acrothyra proavia*—13l, 344i. (See 13l′, p. 182, for additional associated forms.)	

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Cape Breton and New Brunswick—Continued.

Dugald Brook section. [Matthew, 1903, pp. 21–25.]	Localities and species occurring in the Dugald Brook section.	Localities and species occurring elsewhere in Cape Breton shown in their approximate stratigraphic position.
Etcheminian—Continued. Division E2e.	**13e, 344l.** *Obolus (Palæobolus) bretonensis lens*—13e. *Acrothyra proavia*—13e. *Acrothyra sera*—13e. *Acrothyra signata orta*—344l. (See 13e, p. 181, for additional associated forms.)	
Division E2b. Dark purplish-gray feldspathic sandstones..... *Feet.* 57	**10p, 10q, 344o, 372f.** *Obolus (Palæobolus) bretonensis*—10p. *Lingulella atava*—10p. *Lingulella collicia*—10p. *Lingulella triparilis*—10p. *Lingulella* sp.—10p. *Lingulella (Lingulepis) gregwa*—10p. *Lingulella (Lingulepis) longinervis*—10p, 344o, 372f. *Lingulella (Lingulepis)* sp.—10p. *Acrothele avia*—10p. *Acrotreta gemmula*—10p. *Acrothyra proavia*—10p, 10q. *Acrothyra sera*—10p. *Acrothyra signata*—10p. *Acrothyra signata orta*—10p. *Protorthis (Loperia) dugaldensis*—10p. (See 10p and 10q, pp. 176 and 177, for additional associated forms.)	**10p′, 10p″.** *Obolus (Palæobolus) bretonensis*—10p″. *Lingulella (Lingulepis) gregwa*—10p′, 10p″. *Lingulella (Lingulepis) longinervis*—10p′, 10p″. *Acrothele avia*—10p″. *Acrotreta gemmula*—10p″. *Acrothyra sera*—10p′, 10p″. (See 10p″, p. 177, for additional associated forms.)
Division E2a. Dark purplish-gray feldspathic sandstone with beds of gray quartzite about the middle..... 37 Dark purplish-gray feldspathic sandstone with some slate conglomerate.. 33 Gray fine-grained felsite conglomerate and grit.... 3 151	**13d, 13d′, 13d″, 13f, 13g, 13p?, 13p′?.** *Obolus (Palæobolus) bretonensis*—13d′. *Lingulella (Lingulepis) longinervis*—13d, 13d″, 13f, 13g, 13p, 13p′. *Lingulella atava*—13d′. *Lingulella collicia*—13d′. *Acrothele avia*—13d′, 13d″. *Acrothele prima*—13d″. *Acrothyra sera*—13d′, 13f, 13p, 13p′. *Acrothyra signata*—13d′. *Acrothyra signata orta*—13d″. (See 13d and 13g, p. 181, for additional associated forms.)	**307d.** *Obolus selwyni*—307d. *Lingulella atava insulæ*—307d. *Lingulella triparilis*—307d. *Lingulella (Lingulepis) roberti*—307d. *Acrotreta* sp.—307d. *Billingsella retroflexa*—307d. (See 307d, p. 238, for additional associated forms.)
Division E1e. Gray shale with seams of greenish-gray sand and lavender-gray shale..... 3	**344h.** *Obolus* sp.—344h. *Lingulella triparilis*—344h. *Lingulella* cf. *tumida*—344h. *Lingulella* sp.—344h. *Lingulella (Lingulepis) gregwa robusta*—344h. (See 344h, p. 269, for additional associated forms.)	
Division E1d. Compact dark-gray sandy shale..... 21	13t″ (E1c and E1d), **344m.** *Lingulella triparilis*—13t″. *Lingulella (Lingulepis) gregwa*—13t″, 344m. *Lingulella (Lingulepis) gregwa robusta*—344m. *Acrothyra sera*—13t″, 344m. *Acrothyra signata*—13t″. (See 13t″ and 344m, pp. 183 and 270, for additional associated forms.)	**344e, 344n?.** *Obolus* sp.—344e. *Lingulella* cf. *collicia*—344e. *Lingulella torrentis*—344e. *Lingulella (Lingulepis) gregwa*—344e, 344n. *Lingulella (Lingulepis)* sp.—344e. *Acrothyra sera*—344e. (See 344e, p. 269, for additional associated forms.)
Division E1c. Dark-gray shale..... 21	13t″ (E1c and E1d), **344g.** *Lingulella triparilis*—13t″, 344g. *Lingulella (Lingulepis) gregwa*—13t″, 344g. *Acrothyra sera*—13t″, 344g. *Acrothyra signata*—13t″, 344g. (See both 13t″ and 344g, pp. 183 and 269, for additional associated forms.)	
Division E1b. Gray quartzites with sand and clay seams at top.... 6 Shales ? (concealed)..... 10 Purplish-gray finely crystalline trap..... 18	**13t, 13t′, 344k.** *Lingulella triparilis*—13t, 13t″, 344k. *Lingulella tumida*—13t. *Lingulella* sp.—344k. *Lingulella (Lingulepis) gregwa*?—344k. *Acrothele prima*—13t. *Acrothyra signata*—13t, 344k. (See both 13t and 344k, pp. 183 and 270, for additional associated forms.)	
Division E1a. Soft purplish-red shale..... 18 Dark purplish-gray trap and ash rock..... 10 Dark-purple amygdaloid and bright-red slates..... 15 122		

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Cape Breton and New Brunswick—Continued.

Dugald Brook section. [Matthew, 1903, pp. 21–25.]	Localities and species occurring in the Dugald Brook section.	Localities and species occurring elsewhere in Cape Breton shown in their approximate stratigraphic position.
Coldbrook [Matthew, 1903, p. 15]. Felsites..... *Feet.* 185		
Gray shales..... 25	**13k, 344f.** *Micromitra (Iphidella) pannula?*—13k. *Obolus torrentis*—13k, 344f. *Lingulella* cf. *triparilis*—344f. *Lingulella (Lingulepis) pumila*—13k, 344f. *Acrothyra sera*—13k, 344f. *Acrothyra signata prima*—13k, 344f. (See 344f, p. 269, for additional associated forms.)	
Felsitic conglomerate..... 100		
LOWER CAMBRIAN.[a]		

[a] Fossils from the Lower Cambrian have been identified at but two localities (**3a** and **301v**), and these are on Hanford Brook, near St. John, New Brunswick. The Lower Cambrian is not represented in the brachiopod collections from Cape Breton.

Colorado.

Most of the Colorado forms occur in the siliceous beds of the Lower Ordovician. Three localities (**360g–i**) have been identified from the Upper Cambrian and two (**3g** and **360d**) from the Middle Cambrian. For the numbers of all the localities see the index.

Denmark.

See Sweden, Denmark, Finland, and Norway, where the horizons are more or less closely differentiated and correlated, with complete lists of localities and included species.

England, Scotland, and Wales.

Section.	Localities and species.
ORDOVICIAN.	
Bala (Caradoc, Coniston) limestone.	**304n, 366o.** *Lingulella davisi*—304n, 366o.
Llandeilo shales.	**316, 316a.** *Acrotreta nicholsoni*—316, 316a.
Llanvirn.	
Arenig.	
UPPER CAMBRIAN.	
Tremadoc (Shineton, Bronsil, Lower Stockingford?) shales.	**304, 304a, 304h, 304i, 304j?, 304k, 304l, 304p, 305, 305a, 305c, 305e–j, 318w, 366p, 366q.** *Obolus (Bröggeria) salteri*—304a. *Lingulella davisi*—366p, 366q. *Lingulella lepis*—305a, 305c, 305e–j, 366q. *Lingulella nicholsoni*—304a, 304i, 304k. *Lingula* sp.—304a. *Acrothele intermedia*—304j. *Acrotreta belti*—304, 304a, 305. *Acrotreta nicholsoni*—304h, 304l. *Acrotreta* cf. *nicholsoni*—304a. *Acrotreta sabrinæ*—304h, 304i, 304j, 304p. *Acrothyra?*—304a. *Eoorthis carausii*—318w. (See 304a, p. 236, for additional associated forms.)
Upper Lingula flags (White Leaved Oak shales, Dolgelly group, Upper Ffestiniog group).	**304b, 304e, 304f, 305d, 318. 318a, 318b, 318s–v, 366s.** *Micromitra pusilla*—304b. *Obolus (Bröggeria) salteri*—304e. *Lingulella ferruginea*—318u, 318v. *Lingulella lepis?*—305d. *Lingulella nicholsoni*—304b. *Lingulella (Lingulepis) pygmæa*—304f. *Acrotreta sabrinæ*—304b. *Orusia lenticularis*—318, 318a, 318b, 318s–v, 366s.
Middle Lingula flags (Hollybush sandstone).	**304g, 366a.** *Micromitra (Paterina) phillipsi*—304g. *Lingulella davisi*—366a. *Lingulella (Lingulepis) squamosa*—304g. *Acrotreta sagittalis?*—304g. (See 304g, p. 236, for additional associated forms.)

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

England, Scotland, and Wales—Continued.

Section.	Localities and species.
UPPER CAMBRIAN—continued.	
Lower Lingula flags.	**318c, 318g, 318m, 366?, 366d-n, 366r?.** *Lingulella davisi*—318m, 366, 366d-n, 366r. *Acrotreta sagittalis*—318c, 318g.
MIDDLE CAMBRIAN.	
Menevian group.	**316b?, 318d, 318e, 318f, 318h, 318j, 318k, 318l, 318p, 318r.** *Lingulella ferruginea*—318e, 318h, 318j, 318k, 318l. *Acrothele maculata*—318d, 318e, 318f, 318h. *Acrotreta sagittalis*—316b, 318h. *Orbiculoidea pileolus*—318d, 318e, 318p, 318r. *Billingsella hicksi*—318d, 318h, 318p.
Harlech grits.	**318n, 318o, 318q, 366b.** *Lingulella ferruginea*—318n, 318o, 366b. *Orbiculoidea pileolus?*—318q.
Solva.	
MIDDLE? CAMBRIAN.	
Caerfai group.	**318l, 366c.** *Lingulella primæva*—318l, 366c.
LOWER CAMBRIAN.	
Malvern "quartzite" (Comley, Serpulite grit, Fucoid beds).	**304c, 304d, 304o, 316c, 316d.** *Micromitra scotica*—316d. *Micromitra (Paterina) labradorica*—304o. *Micromitra (Paterina) phillipsi*—304c, 304d. *Lingulella zeus*—316c. *Obolella groomi*—304c, 304d. *Olenellus lapworthi?*—316c, 316d. (See 304c, p. 236, for additional associated species.)

Finland.

See Sweden, Denmark, Finland, and Norway, where the horizons are more or less closely differentiated and correlated, with complete lists of localities and included species.

Georgia.

See Tennessee, Georgia, and Alabama, where the horizons are more or less closely differentiated and correlated, with complete lists of localities and included species.

Germany.

See Russia, p. 143 and footnote, for stratigraphic position of four localities from East Prussia.

Idaho.

See Utah, Blacksmith Fork section, where the Idaho localities are shown in their approximate stratigraphic position.

Iowa.

See Wisconsin, Michigan, Minnesota, and Iowa for general discussion of stratigraphy.

Labrador.

See Quebec, Ontario, and Labrador for general discussion of stratigraphy.

Maryland.

See Virginia and Maryland for general discussion of stratigraphy.

Michigan.

See Wisconsin, Michigan, Minnesota, and Iowa for general discussion of stratigraphy.

Minnesota.

See Wisconsin, Michigan, Minnesota, and Iowa for general discussion of stratigraphy.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Missouri.

Section.	Localities and species.
UPPER CAMBRIAN.	
Elvins formation.	**11d, 11 l, 369, 369b, 369c, 369d, 369e.** *Obolus ismene*—369. *Obolus matinalis?*—11d. *Lingulella acutangula?*—11 l. *Lingulella texana*—369. *Linnarssonella girtyi*—369. *Billingsella coloradoensis*—11d, 11 l, 369d, 369e. *Billingsella major?*—369c. *Eoorthis indianola*—369, 369b. *Eoorthis remnicha texana?*—11d, 11 l.
MIDDLE CAMBRIAN.	
Elvins formation (basal part or "*Edgewise beds*").[a]	**11e, 11k, 369a.** *Obolus matinalis?*—11e. *Lingulella acutangula*—11k. *Lingulella similis*—11e. *Lingulella* sp.—11e. *Linnarssonella girtyi*—11e. 11k. *Acrotreta microscopica missauriensis*—11e, 11k. *Billingsella coloradoensis*—11e. *Eoorthis wichitaensis*—369a.
Bonneterre limestone.	**11j, 11m, 369f, 369g, 369h.** *Micromitra* sp.—11m. *Micromitra* (*Paterina*) cf. *stissingensis*—11m. *Obolus lamborni*—11j, 11m, 369f, 369h. *Obolus sinoe*—11j. *Lingulella acutangula*—11j. *Lingulella desiderata*—369g. *Lingulella* cf. *ara*—11m. *Dicellomus nanus*—11j, 11m. *Dicellomus politus*—11m.
Lamotte sandstone.	

Montana and Wyoming.

The sedimentation in Montana and northwestern Wyoming exhibits so many peculiarities that correlation is difficult, even between sections only a few miles apart. The Wolsey shale occupies a position immediately above a sandstone in the Little Belt Mountains and is Middle Cambrian in age. It can thus be closely correlated with the similarly situated Flathead shales of Peale, which are also Middle Cambrian. On Dearborn River, however, a shale which occupies the same stratigraphic position [see Walcott, 1908f, pp. 202–203] carries a typical Lower Cambrian fauna in its lower part and Middle Cambrian in its upper layers. The sandstone underlying the Dearborn River shale horizon is Lower Cambrian in age, and that underlying Peale's Flathead shales has been found to contain a fairly well developed Middle Cambrian fauna.

The Gallatin formation of Peale has a very wide geographic distribution, and collections have been made at many localities. The various horizons can not be differentiated, but the faunas show clearly that his Gallatin is in part Upper Cambrian and in part Middle Cambrian. A limestone in the Phillipsburg quadrangle that is believed to be the equivalent of the Yogo limestone of the Little Belt Mountains has been found to contain both Middle and Upper Cambrian fossils.

The localities (see index for numbers) give all the known data as to the stratigraphy of the different collections.

Nevada: Barrel Spring.

Barrel Spring section. [Walcott, 1908f, pp. 188–189.]	Localities and species in the Barrel Spring section.	Other Lower[b] Cambrian localities and species in Nevada and California shown in their approximate stratigraphic position.
A section of Lower Cambrian strata studied by Mr. F. B. Weeks near Barrel Spring, 16 miles south of the town of Silver Peak, Nevada, is much like that east of Waucoba Springs, and has about the same fauna at various horizons in it.		
LOWER CAMBRIAN.		
Feet.		
1. Massive blue-mottled limestone, with 50 feet of sandy limestone in the middle of the series..... 737	*Archæocyathus* and allied forms occur throughout.	

[a] It has been agreed, but too late for any other correction than the insertion of this footnote, that the "Edgewise beds" should be placed in the Upper Cambrian.

[b] Three scattering localities have been identified as Middle Cambrian, and eight localities were collected from the Emigrant formation (Upper Cambrian) of Turner in the Silver Peak district. See index for locality numbers.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Nevada: Barrel Spring—Continued.

Barrel Spring section. [Walcott, 1908f, pp. 188–189.]		Localities and species in the Barrel Spring section.	Other Lower Cambrian localities and species in Nevada and California shown in their approximate stratigraphic position.
LOWER CAMBRIAN—continued.			
2. Sandy shales succeeded by coarse thin fine sandstone with buff limestone at top	*Feet.* 206	**1m, 1p.** In limestone: *Micromitra (Paterina) prospectensis*—1m, 1p. *Nisusia (Jamesella) amii*—1m, 1p. *Scenella* sp.—1m, 1p. *Agraulos?*—1m, 1p. *Olenellus fremonti*—1p. *Olenellus gilberti*—1m, 1p.	**53, 53a, 174c, 176, 176a, 178a, 312, 312a.** *Mickwitzia occidens*—53, 174c. *Obolus?*—174c. *Obolella vermilionensis*—53, 176. *Obolella* sp.—53a, 174c, 176, 312a. *Trematobolus excelsis*—53, 176a, 312, 312a. *Trematobolus* sp.—178a. *Billingsella highlandensis*—178a. *Wanneria gracile*—53, 178a. *Olenellus fremonti*—178a. *Holmia rowei*—312.
3. Green calcareous shale, arenaceous at top	390	**1l, 1v.** *Archæocyathus ?*—1v. *Micromitra (Paterina) labradorica* var.—1v. *Kutorgina cingulata*—1v. *Kutorgina perugata*—1v. *Siphonotreta? dubia*—1v. *Acrothele spurri?*—1l. *Acrotreta claytoni*—1l. *Swantonia weeksi*—1v. *Swantonia?* sp.—1v. *Stenotheca* cf. *elongata*—1v. *Stenotheca* cf. *rugosa*—1v. *Salterella*—1l. *Ptychoparia* sp.—1l, 1v. *Wanneria gracile*—1v. *Olenellus argentus*—1v. *Olenellus gilberti*—1l.	**7, 141, 140, 14p, 175, 184, 3131.** *Obolus ?*—175. *Lingulella (Lingulepis) rowei*—14p. *Kutorgina perugata*—7, 175, 184, 313i. *Obolella vermilionensis*—14p. *Obolella* sp.—140. *Yorkia wanneri?*—7. *Acrotreta claytoni*—175, 184. *Swantonia* sp.—175. *Billingsella bivia*—141, 14p. *Wanneria gracile*—14p. *Olenellus fremonti*—141, 14p.
4. Massive blue-mottled limestone	49		
5. Mainly green shales, some quartzitic shale, bands of limestone at top	580		
6. Green calcareous shale, with bands of limestone at top	564	**1i, 1k.** *Olenellus claytoni*—1i, 1k. *Olenellus fremonti*—? *Olenellus gilberti*—1i.	
7. Andesite mass	750		
8. Massive blue-mottled limestone	81		
9. Green calcareous shale	238		
10. Mostly thin-bedded blue and gray shaly quartzite	904		
11. Siliceous limestones at base, then blue coral limestone	1,349		
12. Massive quartzite, shaly in places	222	**1f.** *Nevadia weeksi*—1f *Holmia rowei*—1f.	
13. Siliceous buff limestone	180		
Total	6,250		
Base unknown.			

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Nevada: Eureka District.

Eureka district section. [Walcott, 1884b, p. 284; and 1908f, p. 184.]		Localities and species in the Eureka district section.	Other localities and species in eastern Nevada shown in their approximate stratigraphic position.[a]
ORDOVICIAN.			
Pogonip limestone: Interstratified limestone, argillites, and arenaceous beds at the base, passing into purer fine-grained limestone of a bluish-gray color, distinctly bedded and highly fossiliferous	Feet. 2,700	**63, 201a, 202?, 203, 204, 209.** *Obolus anceps*—63. *Obolus mæra*—202. *Obolus (Westonia) iphis*—201a. *Lingulella manticula*—202. *Lingulella poganipensis*—201a. *Lingulella* sp.—202. *Elkania ambigua*—63, 202. *Acrothele* sp.—201a. *Acrotreta idahoensis*—201a, 202. *Acrotreta idahoensis alta*—63. *Schizambon typicalis*—201a. *Schizambon?*—63. *Eoorthis hamburgensis*—201a, 202. *Syntrophia nundina*—63, 201a, 203, 204, 209. (See 201a, 202, and 203, p. 228, for additional associated forms.)	**214a, 214b, 313d, 313k.** *Obolus rotundatus*—313d. *Obolus* sp. undt. c—214a. *Lingulella manticula*—214b. *Linnarssonella minuta*—313k.
PASSAGE BEDS.			
Pogonip limestone (lower portion).		**201, 203a, 205, 206a, 211?** *Obolus mæra*—205, 211. *Obolus (Westonia)* sp. undt. b—205. *Lingulella manticula*—211. *Lingulella poganipensis*—201, 203a, 205, 211. *Acrotreta?? cancellata*—205. *Acrotreta curvata*—205. *Acrotreta idahoensis alta*—201, 206a. *Eoorthis hamburgensis*, 201, 205, 211. (See 203a and 211, pp. 228 and 229, for additional associated forms.)	
UPPER CAMBRIAN.			
Dunderberg shale: Yellow argillaceous shale, layers of chert nodules throughout the bed, but more abundant near the top	350	**56?, 61, 62, 62a?, 64, 65, 66, 313h?, 313j.** *Micromitra sculptilis*—61, 62. *Obolus anceps*—61. *Obolus discoideus*—62, 64, 66, 313j. *Obolus mæra*—61, 313j. *Obolus nundina*—61. *Obolus (Westonia) iphis*—64. *Lingulella desidcrata*—56, 61. *Lingulella manticula*—61, 62. *Lingulella punctata*—61, 62. *Linnarssonella minuta*—313h. *Acrotreta attenuata*—61. *Acrotreta idahoensis*—61. *Acrotreta idahoensis alta*—61, 65. *Acrotreta spinosa*—61, 62, 62a, 65. *Acrotreta* sp.—61. (See 56, 61, 62, 62a, 64, and 66, pp. 206, 211, and 212, for additional associated species.)	**8e, 8f, 8n, 8o, 8p, 313, 313f?.** *Micromitra sculptilis endlichi*—8o. *Micromitra* sp.—8o. *Micromitra (Paterina) crenistria*—313. *Obolus discoideus*—8f. *Obolus rotundatus*—8o, 8p. *Lingulella arguta*—313f. *Lingulella desiderata*—8n, 313. *Lingulella isse*—313. *Lingulella manticula*—8e, 8f, 313f. *Lingulella punctata*—8f, 8o. *Acrotreta idahoensis*—313. *Acrotreta microscopica*—8o. *Acrotreta pyxidicula*—313f. *Eoorthis* sp.—8o. *Eoorthis?*—8f.
Hamburg limestone: Dark-gray granular limestone, surface weathering rough and ragged, with only slight traces of bedding.	1,200		
MIDDLE CAMBRIAN.			
Secret Canyon shale: Yellow and gray argillaceous shales passing into shaly limestone; near the top interstratified layers of shale and thinly bedded limestones	1,600	**58, 60.** *Micromitra sculptilis*—58. *Micromitra (Paterina) crenistria?*—58. *Obolus discoideus*—58. *Obolus mæra*—58. *Obolus mcconnelli*—58. *Obolus nundina*—58. *Obolus (Acritis?) rugatus*—58. *Lingulella clarkei*—58, 60. *Lingulella desiderata*—58 60 *Lingulella punctata*—58 *Lingulella* sp.—60. *Acrothele dichotoma*—58. *Acrotreta idahoensis alta*—58 *Acrotreta microscopica*—58. *Acrotreta pyxidicula*—60. (See both 58 and 60, pp. 209 and 211, for additional associated species.)	**7i, 8m?, 10w, 313b, 313c?, 313e.** *Micromitra sculptilis*—10w. *Micromitra (Paterina) crenistria*—313b. *Obolus mcconnelli*—8m, 10w. *Obolus mcconnelli decipiens*—8m. *Obolus rotundatus*—7i. *Lingulella acutangula*—313c. *Lingulella arguta*—313e. *Lingulella desiderata*—313b, 313c. *Lingulella manticula*—7i. *Lingulella punctata*—7i. *Linnarssonella girtyi*—313e. *Acrotreta idahoensis alta*—7i, 313b.

[a] Some of the localities placed in this column could as well have been correlated with the Utah (House Range) section. Locality 41 has been entered under both.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Nevada: Eureka District—Continued.

Eureka district section. [Walcott, 1884b, p. 284; and 1908f, p. 184.]	Localities and species in the Eureka district section.	Other localities and species in eastern Nevada shown in their approximate stratigraphic position.
MIDDLE CAMBRIAN—continued.		
Eldorado limestone: Gray compact limestone, lighter in color than the Hamburg limestone, traversed with thin seams of calcite; bedding planes very imperfect..... *Feet.* 3,050	**54, 55, 55b?, 57, 57b?, 59?.** *Lingulella arguta*—54, 59. *Lingulella desiderata*—57, 57b. *Lingulella punctata*—54, 57. *Acrotreta attenuata*—59. *Acrotreta definita*—55, 57. *Billingsella whitfieldi*—55, 55b. *Orusia eurekensis*—55b. *Orusia lenticularis*—55b. (See 55, 55b, 57, and 59, pp. 205, 207, and 210, for additional associated species.)	**14m, 313a.** *Lingulella arguta*—14m. *Lingulella arguta?*—313a.
LOWER CAMBRIAN.		
Shales occupying the position of the Pioche formation at Pioche, Nevada, and in the House Range (see p. 158), Utah, and correlated with it.	**52.** *Micromitra (Paterina) prospectensis*—52. *Callavia nevadensis*—52. *Olenellus fremonti*—52. *Peachella iddingsi*—52. (Etc., see p. 201.)	**41.**[a] *Micromitra (Iphidella) pannula*—41. *Acrotreta claytoni*—41. *Acrotreta primæva*—41.
Prospect Mountain quartzite: Bedded brownish-white quartzite, weathering dark brown; ferruginous near the base; intercalated thin layers of arenaceous shales; beds whiter near the summit..... 1,500		

[a] Also in the Utah (House Range) section.

New Brunswick.

See Cape Breton and New Brunswick, where the horizons are closely differentiated and correlated, with complete lists of localities and included species.

Newfoundland: Manuels Brook, Conception Bay.

Manuels Brook section. [Walcott, 1891b, pp. 260–261.]	Localities and species in the Manuels Brook section.	Other localities and species in Newfoundland shown in their approximate stratigraphic position.
LOWER ORDOVICIAN. (Not exposed.)		**114b, 314c, 314d, 314g.** *Obolus cyane*—314d. *Obolus? murrayi*—314g. *Obolus (Lingulobolus) affinis*—114b. *Obolus (Lingulobolus) spissus*—114b. *Obolus (Westonia) rogersi*—114b. *Lingulella bella*—114b. *Lingulella iole*—314d. *Acrotreta gemma*—314d. *Syntrophia calcifera*—314c. (See 314c and 314d, pp. 246 and 247, for additional associated forms.)
UPPER CAMBRIAN.		**114, 114a.** *Lingulella bella*—114, 114a. *Lingulella bellula*—114, 114a.
(8) Alternating bands of dark shale and dark, compact sandstone..... *Feet.* 400	**3, 6u, 6v.** *Lingulella ferruginea*—6u. *Acrothele matthewi*—3. *Acrotreta sagittalis transversa*—3. *Orusia lenticularis*—3, 6v.	**6s, 6y, 314a?, 314i?.** *Lingulella billingsiana*—314a. *Lingulella ferruginea?*—6s. *Lingulella randomensis*—6y. *Orusia lenticularis*—314i.
MIDDLE CAMBRIAN. (7) Dark argillaceous shales, with thin layers of limestone and sandstone at various horizons..... 295	**1** (zone A) and **2** (zone B). *Obolus fragilis*—1, 2. *Lingulella ferruginea*—1, 2. *Acrothele matthewi*—1, 2. *Acrotreta misera*—1, 2. (See both 1 and 2, p. 161, for additional associated forms.)	**2a, 6i** (corresponding to zone A). *Lingulella ferruginea*—2a. *Acrotreta sagittalis*—6i. *Agnostus*—6i. *Microdiscus*—6i.
(6) Green argillaceous shale, with thin layers of hard dark ferruginous sandstone interbedded at several horizons..... 270	**1a, 6l, 6n, 6r, 314h?.** *Obolus fragilis*—1a. *Lingulella ferruginea*—1a, 6n, 6r. *Acrothele matthewi*—1a, 6l, 6n. *Acrothele prima costata*—6n. *Acrotreta misera*—6n, 314h. *Acrotreta?*—6l. *Eoorthis papios*—6l.	**6h, 6w, 314.** *Acrotreta misera*—6h, 314. *Acrotreta sagittalis*—6w. (See 314, p. 246, for additional associated forms.)

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Newfoundland; Manuels Brook, Conception Bay—Continued.

Manuels Brook section. [Walcott, 1891h, pp. 260–261.]	Localities and species in the Manuels Brook section.	Other localities and species in Newfoundland shown in their approximate stratigraphic position.
MIDDLE CAMBRIAN—continued.		
(5) Calcareous sandstone, with pinkish limestone in irregular masses.... *Feet.* 2		
(4) Reddish-colored argillaceous shale. 4		
(3) Greenish argillaceous shale..... 40		**6g?** *Micromitra (Iphidella) ornatella*—6g. *Micromitra (Iphidella) pannula maladensis*—6g. *Lingulella ferruginea*—6g. *Acrothele matthewi*—6g. *Acrotreta misera*—6g. *Acrotreta sagittalis*—6g.
LOWER CAMBRIAN.		**5o, 314b.** *Kutorgina granulata*—314b. *Obolella atlantica*—5o. *Olenellus?*—5o.
		5n. *Obolella atlantica*—5n. *Callavia bröggeri*—5n.
(2) Irregular beds of calcareous sandstone, siliceous limestone, and greenish argillaceous shale, covering the upper surface of (1)..... 0–25	**5r, 41.** *Micromitra (Paterina) labradorica*—5r. *Obolella atlantica*—41. *Callavia bröggeri*—5r, 41. (See 41, p. 199, for extensive list of associated species.)	**5l, 5p, 5t, 41a, 314e, 314f.** *Micromitra (Paterina) bella*—314e. *Micromitra (Paterina) labradorica*—5l, 5t, 41a, 314e, 314f. *Obolella atlantica*—5p, 5t, 41a. *Obolella chromatica*—314f. *Mesonacis vermontana*—314f. *Callavia bröggeri*—5p, 5t, 41a. *Olenellus?*—5l.
(1) Coarse conglomerate, in massive layers, resting on gneiss..... 35		

New York.

Five or six of the New York localities are scattering; the remainder may be separated into two groups, Upper Cambrian (Potsdam) and Lower Cambrian. In each of these divisions little stratigraphic differentiation is possible, but the localities (see index for numbers) give all known stratigraphic data.

Norway.

See Sweden, Denmark, Finland, and Norway, where the horizons are differentiated and correlated, with complete lists of the localities and included species.

Nova Scotia.

See Cape Breton and New Brunswick, where the horizons are closely differentiated and correlated, with complete lists of localities and included species.

Oklahoma: Arbuckle Mountains.

For the Arbuckle limestone the section 7 miles north of Springer, on the south side of the Arbuckle Mountains, is used, and for the Reagan sandstone a section measured by E. O. Ulrich in sec. 2, T. 4 N., R. 13 W., on the north side of the Arbuckle Mountains, 15 miles northwest of Fort Sill.

Springer section, south side of Arbuckle Mountain.		Localities and species in the Springer section.	Other localities and species in Oklahoma in their approximate stratigraphic position.
ORDOVICIAN.			
Arbuckle limestone:[a]	*Feet.*		
1. Compact dolomitic limestone with occasional calciferous fossils, nearly	4,500		
2. Rather thin-bedded, mostly compact, gray or blue limestone, with granocrystalline layers in lower half containing fossils, mainly trilobites	250		
3. Crystalline limestone weathering dark and breaking down into rough howldery jointed masses, in which the sedimentation is much obscured. Upper member granocrystalline and gray; middle member with white and pink marble; lower member granocrystalline and dark gray to white	305		

[a] The section of the Arbuckle limestone was measured on the south side of the Arbuckle Mountains, 7 miles north of Springer.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Oklahoma: Arbuckle Mountains—Continued.

Springer section, south side of Arbuckle Mountains.	Localities and species in the Springer section.	Other localities and species in Oklahoma in their approximate stratigraphic position.
UPPER CAMBRIAN.		
Arbuckle limestone: Feet.		
4. Heavy bedded compact gray limestone..... 4		
5. Thin-bedded shaly limestone with fossils..... 4	**12m.** *Obolus tetonensis ninus*—12m. *Lingulella similis*—12m. *Eoorthis remnicha texana*—12m.	**9z, 12j.** *Eoorthis wichitaensis*—9z, 12j.
6. Heavy bedded compact gray limestone..... 4		
7. Thin-bedded shaly and clayey limestoue, often yellow, with some limestone conglomerate; no fossils..... 0–40		

Section measured in sec. 2, T. 4 N., R. 13 W., north side of Arbuckle Mountains, by E. O. Ulrich.	Localities and species occurring in the section quoted.	Localities and species occurring in the Springer section (12k and 12n) and elsewhere in Oklahoma shown in their approximate stratigraphic position.
UPPER CAMBRIAN.		
Reagan sandstone:[a] Feet.		
1. Highly calcareous sandstone, with numerous pure crystalline limestone lenses and layers containing fossils..... 175		
(125 feet above the base.)	**9u.** *Obolus tetonensis ninus*—9u. *Lingulella similis*—9u. *Eoorthis indianola*—9u. *Eoorthis wichitaensis*—9u. *Syntrophia primordialis*—9u.	**9q?, 9s, 9w, 12n, 12p?.** *Obolus tetonensis ninus*—9q, 9s, 12n, 12p. *Lingulella similis*—9s, 12n, 12p. *Lingulella ora*—9q. *Lingulella (Lingulepis) acuminata*—9q, 9s, 12n, 12p. *Linnarssonella girtyi*—9q, 12p. *Acrotreta curvata*—12p. *Acrotreta microscopica*—12n, 12p. *Acrotreta ulrichi*—12p. *Eoorthis indianola*—9w, 12n, 12p. *Eoorthis remnicha*—12n, 12p. *Eoorthis remnicha texana*—12n. *Eoorthis wichitaensis*—9q, 9s, 12n, 12p. *Eoorthis wichitaensis læviusculus*—12n, 12p. *Syntrophia primordialis*—12n.
(100 feet above the base.)	**9t.** *Obolus matinalis*—9t. *Obolus tetonensis ninus*—9t. *Lingulella similis*—9t. *Acrotreta microscopica*—9t. *Eoorthis indianola*—9t.	**12k.** *Obolus tetonensis ninus*—12k. *Lingulella similis*—12k. *Acrotreta microscopica*—12k. *Eoorthis indianola*—12k. *Eoorthis remnicha*—12k. *Eoorthis wichitaensis*—12k. *Eoorthis wichitaensis læviusculus*—12k.
(90 feet above the base.)	**9p.** *Obolus tetonensis ninus*—9p. *Lingulella ora*—9p. *Linnarssonella girtyi*—9p.	**9x.** *Dicellomus politus.*
(45 feet above the base.)	**12s.** No brachiopods. Trilobites not studied.	**9v?.** *Lingulella (Lingulepis) acuminata*—9v. *Linnarssonella girtyi*—9v.
2. Originally massive calcareous sandstone, now leached into laminar, favose masses, forming small bluffs..... 25		
(Beds between 2 and 3 are fossiliferous.)	**9r.** *Obolus tetonensis ninus*—9r. *Lingulella similis*—9r. *Linnarssonella girtyi*—9r. *Acrotreta microscopica*—9r.	
3. Whitish crystalline limestone, almost made up of fragments of large cystids. With the limestone small lenses and layers of glauconitic sandstone are interpolated..... 24		
Base formed of a glauconitic grit 20 feet thick, containing several layers of porphyry pebbles and resting on porphyry.		

[a] The section of the Reagan sandstone was measured on the north side of Arbuckle Mountains, in sec. 2, T. 4 N., R. 13 W. The Reagan is much more fossiliferous and has a greater development in the section northwest of Fort Sill, in Comanche County, than it has on the south side of the Arbuckle Mountains, in Carter County.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Ontario.

See Quebec, Ontario, and Labrador for general discussion of stratigraphy.

Pennsylvania.

All but two of the Pennsylvania localities (see index for numbers) are from approximately the same horizon in the Lower Cambrian. One locality (**346b**) is from the Upper Cambrian and one (**48d**) from the Middle Cambrian.

Quebec, Ontario, and Labrador.

Three general horizons from Quebec and Ontario are represented in the collections: An Ordovician (Chazy?), an Upper Cambrian equivalent to the Potsdam of New York, and a Lower Cambrian in limestone pebbles in a conglomerate. The Lower Cambrian forms may be compared with those occurring in localities **392a**, **392c**, and **392l**, all at the Straits of Belleisle, Labrador. See index for numbers of all localities in Quebec, Ontario, and Labrador.

Russia.[a]

Section.	Localities and species.
ORDOVICIAN. *Jewe limestone* (D).	**337e.** *Siphonotreta unguiculata*—337e.
Itfer limestone (C3).	
Kucker limestone (*"Brandschiefer"*) (C2).	**337d.** *Siphonotreta unguiculata*—337d.
Echinosphærites limestone (C1).	**336, 336g?, 336v, 336w, 336x, 386i-l.** *Volborthia recurva*—336g. *Acrotreta subconica*—336. *Siphonotreta unguiculata*—336g, 336v, 336w, 336x, 386i, 386j. *Siphonotreta verrucosa*—336w, 386i, 386k, 386l.
Upper "Linsenschicht."	
PASSAGE BEDS. *Orthoceratite* (*Vaginoceras*) *limestone* (*"Vaginatenkalk"*) (B3): B3γ=*Asaphus eichwaldi* zone. B3β=*Asaphus raniceps* zone. B3α=*Asaphus expansus* zone.	**336d, 336e, 336f, 336z, 337, 337a, 337b, 337c, 337f, 337g, 337h, 337j, 337k, 337l, 337m, 396n, 396p.** *Volborthia recurva*—337j. *Obolus* (*Mickwitzella*) *siluricus*—336f. *Obolus* (*Acritis*) *antiquissimus*—336d, 336e, 337h, 396n, 396p. *Siphonotreta unguiculata*—336e, 336z, 337, 337a, 337b, 337c, 337k, 337l. *Siphonotreta verrucosa*—336e, 337f, 337g, 337m.
Lower "Linsenschicht."	
Glauconite limestone (B2): B2γ=*Asaphus lepidurus* zone. B2β=*Asaphus böggeri* zone. B2α=*Megalaspis planilimbata* zone.	**336y, 396g-o, 396z.** *Obolus* (*Acritis*) *antiquissimus*—396g-o, 396z. *Siphonotreta unguiculata*—336y. *Siphonotreta verrucosa*—336y.
Glauconite sandstone (B1).	**337i, 395v?, 395w, 395x?, 395y?, 396, 396a-f, 396x, 396y.** *Obolus* (*Mickwitzella*) *siluricus*—337i, 395v, 395w, 395x, 395y, 396, 396a-c, 396e, 396x, 396y. *Obolus* (*Acritis*) *antiquissimus*—395w, 396d, 396x, 396y. *Obolus* (*Acritis*) *antiquissimus ventrosus*—396d. *Lingulella* (*Leptembolon*) *lingulæformis*—396, 396a-d, 396f. *Lingulella* (*Leptembolon*) *lingulæformis solidus*—396a.
UPPER CAMBRIAN. *Dictyograptus slate.*	
Ungulite grit or *Obolus sandstone.*	**9d, 336a, 336b, 336c, 336h, 336j-u, 395, 395a-e, 395z.** *Obolus apollinis*—9d, 336a-c, 336k-m, 336r-u, 395, 395b, 395z. *Obolus apollinis ingricus*—336a, 336c, 336s, 336t, 395, 395a, 395z. *Obolus apollinis maximus*—336j, 395. *Obolus apollinis quenstedti*—395, 395a, 395z. *Obolus eichwaldi*—395. *Obolus elegans*—395, 395b. *Obolus ponderi*—395. *Obolus schmidti*—395. *Obolus triangularis*—9d. *Obolus volborthi*—395. *Obolus* sp.—9d, 336p. *Obolus* (*Schmidtia*) *acuminatus*—395, 395a-e. *Obolus* (*Schmidtia*) *acuminatus alatus*—395, 395a-e. *Obolus* (*Schmidtia*) *acuminatus humeratus*—395, 395a, 395b. *Obolus* (*Schmidtia*) *acuminatus subtriangularis*—395, 395b. *Obolus* (*Schmidtia*) *celatus*—336o, 336p, 395. *Obolus* (*Schmidtia*) *celatus præcisus*—395, 395a-e. *Obolus* (*Schmidtia*) *crassus*—395, 395a-e. *Obolus* (*Schmidtia*) *crassus angulatus*—395, 395b.

[a] Four drift bowlders found in East Prussia (localities **386l-l**) are included.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Russia—Continued.

Section.	Localities and species.
Ungulite grit or *Obolus sandstone*—Continued.	**9d, 336a, 336b, 336c, 336h, 336j-u, 395, 395a-e, 395z**—Continued. *Obolus (Schmidtia) obtusus*—395, 395b. *Obolus (Schmidtia) obtusus acutus*—395. *Obolus (Schmidtia) obtusus ellipticus*—395, 395b. *Obolus (Schmidtia) obtusus extenuatus*—395. *Obolus (Schmidtia) obtusus latus*—395. *Obolus (Schmidtia) obtusus longus*—395. *Obolus (Schmidtia) obtusus minutus*—395. *Lingulella (Leptembolon) lingulæformis*—395. *Helmersenia ladogensis*—336c-q. *Keyserlingia buchi*—9d, 336a, 336n-p, 395, 395b. *Schizambon? esthonia*—336h.
Obolus conglomerate and sandstone below it (*Schmidtia conglomerate*).	**336i, 395f-u.** *Obolus apollinis*—395f. *Obolus apollinis maximus*—395f. *Obolus triangularis*—336i, 395g, 395i. *Obolus triangularis inornatus*—395g. *Obolus (Schmidtia) celatus*—395g-i, 395o, 395s-u. *Obolus (Schmidtia) celatus orbiculatus*—395g-r. *Obolus (Schmidtia) celatus præcisus*—395g-r.
Unconformity.	
LOWER CAMBRIAN. *Fucoid sandstone.*	
Mickwitzia conglomerate.	**396q-w.** *Mickwitzia monilifera*—396q-w. *Mesonacis mickwitzi*—396r, 396u, 396v.
Blue clay.	

Scotland.

See England, Scotland, and Wales, where the horizons are more or less closely differentiated and correlated, with complete lists of localities and included species.

South Dakota and Wyoming.

Three of the localities (**302e, 302p**, and **302u**) occur in the upper part of the Deadwood formation and have been referred to the Upper Cambrian; the remainder (see index for numbers) occur in the Middle Cambrian at various more or less closely related horizons in the Deadwood formation. (See also Montana and Wyoming.)

Sweden, Denmark, Finland, and Norway.

Section.	Localities and species in Sweden, Denmark, and Finland in their approximate stratigraphic position.	Localities and species in Norway in their approximate stratigraphic position.
PASSAGE BEDS. *Orthoceras limestone:* *Didymograptus slate.*		
Phyllograptus slate (Planilimbata limestone).		**323, 323i.** *Obolus (Bröggeria) salteri*—323i. *Acrotreta sagittalis*—323.
	390, 390f. (Both given as occurring between either the lower graptolite slate or the *Orthoceras* limestone and the *Ceratopyge* limestone.) *Protorthis hunnebergensis*—390f. *Eoorthis tullbergi*—390.	
Ceratopyge limestone (3aγ) (Apatocephalus zone).	**309, 310, 310j, 310w?, 310x, 320w, 323j, 390e.** *Obolus? inflatus*—310x. *Obolus (Bröggeria) salteri*—309, 323j. *Lingulella lepis*—309, 310, 310j, 310w, 320w. *Acrothele ceratopygarum*—310. *Acrotreta carinata*—309, 310. *Acrotreta circularis*—309, 310. *Acrotreta sagittalis*—309. *Eoorthis daunus*—310, 310j. *Eoorthis wimani*—310j. *Eostrophomena elegantula*—310, 310j, 390e. (See 309 and 310, pp. 240 and 241, for additional associated forms.)	**8x, 323, 323c-h, 323z.** *Obolus (Bröggeria) salteri*—8x, 323e, 323f, 323h. *Lingulella lepis*—8x, 323c, 323f, 323h. *Lingulella* sp.—8x. *Lingula* sp.—323h. *Acrothele ceratopygarum*—323h. *Acrothele coriacea*—8x. *Acrotreta secbachi*—8x, 323d-h. *Acrotreta sagittalis*—8x, 323. *Acrotreta sagittalis* var.—323h. *Eoorthis daunus*—8x, 323f, 323h, 323z. *Eoorthis wimani*—8x. (See 8x, 323f, and 323h, pp. 173 and 257, for additional associated forms.)

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Sweden, Denmark, Finland, and Norway—Continued.

Section.	Localities and species in Sweden, Denmark, and Finland in their approximate stratigraphic position.	Localities and species in Norway in their approximate stratigraphic position.
UPPER CAMBRIAN.		
Ceratopyge slate (3aβ) (Shumardia zone).	**309i?, 309j?, 309l?, 310d, 310h?, 310k, 310r, 310s, 321e-n, 323k, 390b, 390c, 390l, 390o??.** *Obolus (Bröggeria) salteri*—309i, 309j, 309l, 310d, 310h, 323k, 390i. *Lingulella concinna*—310h. *Lingulella ferruginea*—310d. *Lingulella lepis*—310d, 321l, 321m. *Lingulella* sp. undt. a—310k. *Obolella* sp.—321n. *Acrothele borgholmensis*—310d. *Acrotreta ælandica*—310r, 310s. *Acrotreta* cf. *sagittalis*—321e–n. *Acrotreta seebachi*—310d. *Acrotreta* sp.—321n. *Eoorthis christianiæ*—310d. *Eoorthis wimani*—390b, 390c. *Billingsella exporrecta*—310h. *Orusia lenticularis*—390o. (See 321e–n, 390b, 390c, pp. 254, 255, 279, and 280, for additional associated forms.)	**323a, 323w, 323x, 323y.** *Obolus* sp—323w. *Obolus (Bröggeria) salteri*—323w. *Lingulella lepis*—323a. *Acrotreta sagittalis*—323a. *Eoorthis christianiæ*—323x, 323y. *Eoorthis wimani*—323w.
Bryograptus slate (3aα).	**309a.** *Lingulella lepis*—309a.	
Dictyograptus slate (Obolus sandstone).	**9e, 309b, 309h, 310n, 310t, 310u, 310v, 311v, 311w, 321, 321a-d, 321o, 321x, 390g, 390l, 390m.** *Obolus apollinis*—9e, 311v, 311w, 321, 321a–d, 321o, 390l, 390m. *Obolus triangularis*—310n. *Obolus (Bröggeria) salteri*—309h, 321x, 390g. *Obolus (Schmidtia) celatus orbiculatus*—321d. *Obolus (Schmidtia) obtusus*—321c. *Lingulella lepis*—309b. *Acrotreta* sp.—310t–v. *Orthis* sp.—311w.	
Acerocare zone, Olenus zone, and Étage 2b.	**309e, 309m, 310a, 390n, 390p?.** *Acrotreta conula*—310a. *Orusia lenticularis*—309m, 310a, 390n, 390p. *Eoorthis christianiæ*—309e. *Parabolina spinulosa*—390n.	**9f, 3231-v.** *Lingulella lepis*—9f. *Orusia lenticularis*—9f, 3231–v. *Parabolina spinulosa*—3231, 323m, 323o–u. *Peltura scarabæoides*—323n.
MIDDLE CAMBRIAN.		
Agnostus lævigatus zone.	**310i?, 310q, 320?, 320a, 320b, 320r, 320u, 321p.** *Micromitra pusilla*—320u. *Lingulella agnostorum*—310i. *Lingulella ferruginea*—310q. *Acrothele coriacea*—310i, 320b, 320r. *Acrothele (Redlichella) granulata*—320b. *Acrotreta parvula*—310i, 320, 320a. *Billingsella exporrecta*—320b, 321p. *Billingsella exporrecta rugosicostata*—320b.	
Poradoxides forchhammeri zone (Étage 1d, Norway; Andrarum limestone; and Coronatus zone, 320i–k).	**8w, 16h, 16j, 310b?, 310l, 310y, 310z, 320c, 320e?, 320f, 320g, 320i?, 320j?, 320k?, 320m, 320n, 320p, 320q, 320v, 320y, 320z, 321q, 321r, 321t?, 321u?, 321y?, 321z?, 334, 334b, 334e, 334f?, 334g?, 334h.** *Micromitra pusilla*—8w, 16h, 16j, 320f. *Micromitra (Iphidella) ornatella*—8w, 16h, 320f, 320n, 320y. *Obolus schmalenseei*—8w, 16h. *Lingulella ferruginea*—8w, 16b, 16j, 310y, 310z, 320m, 320n. *Lingulella linnarssoni*—320n. *Lingulella* sp.—8w. *Dicellomus* sp. undt.—310l. *Acrothele coriacea*—8w, 16h, 16j, 321f, 320g, 320k, 320m, 320n, 320p, 320q, 320v, 320y, 321q, 334b, 334c, 334f, 334h. *Acrothele intermedia*—16h, 320i, 320j, 320k, 320q. *Acrotreta sagittalis*—8w, 16h, 16j, 321y, 321z, 334h. *Acrotreta schmalenseei*—8w, 16h, 16j, 310b, 320c, 320e, 320m, 320n, 321q, 334. *Acrotreta socialis*—8w, 320n, 334g. *Billingsella exporrecta*—310z, 320g, 320m, 320n, 320p, 320y, 320z, 321q, 321. *Billingsella exporrecta rugosicostata*—320m, 320n, 320p. *Billingsella lindströmi*—320m, 320n, 320p, 320q, 320y, 321t, 321u. *Orusia lenticularis*—320f. (See 8w, 16h, 320q, and 334g, pp. 173, 186, 253, and 262, for additional associated forms.)	**324c, 324d?.** *Micromitra (Iphidella) ornatella*—324c. *Lingulella ferruginea*—324d. *Acrothele coriacea*—324c.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Sweden, Denmark, Finland, and Norway—Continued.

Section.	Localities and species in Sweden, Denmark, and Finland in their approximate stratigraphic position.	Localities and species in Norway in their approximate stratigraphic position.
MIDDLE CAMBRIAN—continued.		
Paradoxides davidis zone.	**16k, 16l.** *Acrothele coriacea*—16k, 16l. *Acrotreta sagittalis*—16k, 16l.	
Paradoxides tessini zone, Agnostus parvifrons zone, Conocoryphe exsulans zone, and Etage 1c (Norway).	**16i, 310m, 310o, 311x, 320d, 320h, 334a, 334c, 334d.** *Obolus schmalenseei*—16i. *Obolus (Westonia) finlandensis*—311x. *Lingulella ferruginea*—310m, 310o. *Lingulella* sp.—16i. *Acrothele coriacea*—334c, 334d. *Acrothele intermedia*—320h, 334a. *Acrotreta sagittalis*—16i. *Acrotreta schmalenseei*—320d. *Liocephalus impressa*—16i.	**324a, 324b.** *Acrothele coriacea*—324a, 324b. *Agnostus nudus*—324b.
Paradoxides œlandicus zone.	**8z, 309f?, 310c, 310p, 320l, 320s?, 320t.** *Obolus* sp. undt. g—320l. *Lingulella ferruginea*—310p. *Acrothele coriacea*—320l. *Acrothele (Redlichella) granulata*—8z, 309f, 320l, 320s, 320t. *Acrotreta schmalenseei*—310c, 310p. *Acrotreta socialis*—8z. *Acrotreta* sp.—8z. *Billingsella exporrecta*—320l. *Billingsella lindströmi*—320l. (See 8z, p. 173, for additional associated forms.)	**323b.** *Acrotreta schmalenseei*—323b.
MIDDLE ? CAMBRIAN.	**311, 311a-u, 311y, 320o.** *Mickwitzia formosa*—311l, 311s. *Mickwitzia monilifera*—311e, 311f, 311l, 311q, 311r, 311n. *Obolus (Westonia) ölandensis*—311j, 311k, 311m, 311y. *Obolus (Westonia) balticus*—311h, 311o, 311t. *Obolus (Westonia) bottnicus*—311, 311e. *Obolus (Westonia) wimani*—311c, 311g, 311i, 311t. *Lingula* or *Lingulella*—311c, 311j, 311p, 311t, 311y. *Acrothele coriacea*—320o. *Acrotreta eggegrundensis*—311, 311a, 311d. *Acrotreta uplandica*—311h, 311p. *Acrotreta uplandica limöensis*—311n. (See 311, 311c, 311g, 311k, 311m, 311n, 311s, 311t, 311y, pp. 243-245, for additional associated forms.)	
LOWER CAMBRIAN.		
Holmia kjerulfi zone (Mesonacis torelli zone).	**320x, 321s, 321v.** *Lingulella nathorsti*—320x. *Obolella lindströmi*—321s, 321v. *Obolella mobergi*—321s, 321v. *Mesonacis torelli*—321v. *Holmia kjerulfi*—320x.	**8v, 324.** *Lingulella* sp.—324. *Obolella mobergi*—8v, 324. *Obolella (Glyptias) favosa*—324. *Acrothele bellapunctata*—8v. *Holmia kjerulfi*—324. *Arionellus*—324.
Fucoid sandstone.	**309c, 309d, 310e?, 310f?, 310g?, 390a?, 390d?, 390h.** *Micromitra (Paterina) undosa*—310f, 330a, 390d, 390h. *Obolella (Glyptias) favosa*—309c, 309d. *Acrothele* sp. undt.—310e. *Acrothele* sp. undt.—310f, 310g. *Discinella*—310f, 390a, 390d, 330h.	
Eophyton sandstone (Mickwitzia conglomerate, Sparagmite sandstone).	**8y, 390j, 390k.** *Mickwitzia monilifera*—390j, 390k. *Mickwitzia pretiosa*—390j. *Lingulella nathorsti*—8y. (See 8y and 390j, pp. 173 and 280, for additional associated forms.)	

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Tennessee, Georgia, and Alabama.

Section.		Localities and species in Tennessee in their approximate stratigraphic position.	Localities and species in Georgia and Alabama in their approximate stratigraphic position.
UPPER CAMBRIAN.			
Knox dolomite.		**7d?, 12q, 105, 107o, 107u, 122?, 122a?, 128?, and 128a?.** *Obolus lamborni*—7d, 122. *Obolus willisi*—122. *Lingulella desiderata*—107o, 107u, 122, 122a. *Lingulella ino*—7d. *Lingulella* sp.—128a. *Lingulella?*—128. *Lingulella (Lingulepis) acuminata*—105. *Acrotreta kutorgai*—107o, 107u. *Syntrophia campbelli*—12q.	**93, 93a, 93n, 93o, 93x, 94o, 96, 361?, 362?.** *Micromitra alabamaensis*—94o. *Micromitra (Iphidella) pannula*—96. *Obolus rotundatus*—96. *Obolus willisi*—93, 93n, 93x. *Lingulella desiderata*—93, 93a, 93o, 94o, 96, 361, 362. *Lingulella leos*—96. *Acrotreta kutorgai*—361. *Acrotreta* sp.—94o.
MIDDLE CAMBRIAN.			
Nolichucky shale.	Conasauga shale, not differentiated in Georgia and Alabama. See third column for species.	**2z, 11a??, 124, 124a, 374c, 374d?.** *Micromitra alabamaensis*—124. *Obolus lamborni*—124a. *Obolus lamborni minimus*—124. *Obolus sinoe*—11a. *Lingulella tarpa*—11a. *Lingulella (Lingulepis) acuminata*—124a, 374d. *Dicellomus appalachia*—2z, 11a, 124a, 374c.	**16, 56o, 56q, 56u, 89, 90, 90a, 90b, 90c, 90x, 91, 92x, 94, 94a, 94x, 94xx, 95a, 96b, 96x?, 137, 138?, 139, 139a, 140, 140a, 140c, 141a, 144c?, 145?, 146, 362a?.** *Micromitra alabamaensis*—90x, 94, 94a, 95. *Micromitra (Paterina) major*—90. *Obolus lamborni*—140a. *Obolus sinoe*—92x. *Obolus willisi*—94, 94a, 96b, 140a, 146, 362a. *Obolus (Westonia) ella*—90, 141a. *Lingulella buttsi*—90b, 90c. *Lingulella desiderata*—90b, 94xx, 139. *Lingulella hayesi*—90x, 94a. *Lingulella nanno*—16, 91. *Lingulella quadrilateralis*—56q, 91, 140a. *Lingulella similis*—90, 92x, 138, 140c, 145. *Lingulella* sp.—140c. *Lingulella (Lingulepis) acuminata*—89. *Acrothele bellula*—90x, 94x. *Acrotreta concentrica*—96x. *Acrotreta kutorgai*—90, 90b, 90x, 137, 139a, 140. *Acrotreta* sp.—56o, 56u, 94xx. *Dicellomus appalachia*—16, 89, 90a, 90b, 91, 144c. *Wimanella anomala*—90. *Agnostus*—90b. *Ptychoparia* sp.—56q, 90b, 90x. *Anomocare*—90x. *Olenoides curticei*—90, 90x. *Laotira cambria*—90x. *Brooksella alternata*—90x.
Maryville limestone.	Honaker limestone. 2z?. *Dicellomus appalachia.*	**123.** *Micromitra alabamaensis*—123. *Ptychoparia*—123.	
Rogersville shale.		**18??, 101, 101a, 101b, 102, 102c?, 121, 121a?.** *Micromitra alabamaensis*—121, 121a. *Micromitra (Iphidella) pannula*—101. *Obolus lamborni*—101b, 102, 121. *Obolus lamborni minimus*—101, 101a. *Obolus willisi*– 101b, 121. *Lingulella desiderata*—101a. *Dicellomus appalachia*—102. *Acrotreta kutorgai?*—18. *Acrotreta rudis*—101a, 102c, 121. *Billingsella appalachia*—121. *Wimanella harlanensis*—121.	
Rutledge limestone.			
Rome formation.		**9?, 9a?, 10a, 10b, 11, 12?, 13, 13b, 14a, 103, 103a, 103b, 104?, 106, 106a?, 107, 107a, 107b, 117?, 117c, 118, 119?, 374?, 374a?, 374b?, 374c?.** *Micromitra alabamaensis*—14a. *Obolus lamborni*—103. *Obolus lamborni minimus*—103a, 118. *Obolus pandemia*—10a. *Obolus willisi*—106a, 107a, 107b, 374e. *Obolus (Westonia) ella*—14a. *Lingulella auga*—10a, 10b. *Lingulella desiderata*—9, 9a, 103b, 107a, 117. *Lingulella ino*—11, 13, 13b. *Lingulella similis*—9a, 10a, 14a, 106, 374. *Lingulella tarpa*—11. *Lingulella?*—107b. *Dicellomus appalachia*—103a, 104, 107, 107b, 117c, 119, 374a, 374b. *Linnarssonella tennesseensis*—12, 13, 107b. *Wimanella harlanensis*—107. *Wimanella saffordi*—14a.	**13c, 14, 138a, 142, 164f?.** *Micromitra (Iphidella) pannula*—14. *Obolus?* sp.—164f. *Lingulella ino*—13c. *Lingulella similis*—138a. *Acrotreta kutorgai?*—142. *Billingsella appalachia*—14. *Dorypyge?*—14.
LOWER CAMBRIAN.			
Rome formation, basal part, locally known in Alabama as "Montevallo shale."			**17b, 56c.** *Micromitra (Paterina) major*—17b, 56c. *Micromitra (Paterina) williardi*—17b, 56c. *Obolus smithi*—17b, 56c. *Wimanella shelbyensis*—17b, 56c. *Pædeumias transitans*—56c. *Wanneria halli*—56c. *Agraulos?*—56c. *Hyolithes*—56c.
Beaver limestone.			
Weisner quartzite.			**59m.** *Obolella* cf. *atlantica*—59m. *Obolella* cf. *crassa*—59m. *Archæocyathus*—59m. *Stenotheca* cf. *rugosa*—59m. *Olenellus thompsoni*—59m.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Texas.

The Texas localities are from the Upper Cambrian, at about the stratigraphic horizon of the Reagan sandstone of the Oklahoma section.

Utah: Blacksmith Fork, Cache County.

Blacksmith Fork section. [Walcott, 1908f, pp. 190–200.]		Localities and species in the Blacksmith Fork section.	Other localities and species in Utah and Idaho shown in their approximate stratigraphic position.
The Blacksmith Fork section is located in Blacksmith Fork Canyon, on the east side of Cache Valley, in the Wasatch Mountains, between Ute and Logan Peaks, about 10 miles east of Hyrum, in northern Utah. This section is 230 miles northeast of the House Range section (Utah) and is north of the greater effect of the pre-Cambrian Uinta Mountain uplift and island. The character of the sediments derived from the Uinta area is shown by the continuation of the arenaceous deposits up to the middle of Middle Cambrian time, whereas in the House Range section the arenaceous deposits cease before the Middle Cambrian fauna appears. It is not until after the Belt Mountain and Kintla (of the 49th parallel) uplifts to the north are passed that the order of sedimentation as shown in the Mount Bosworth section is again of the type of the House Range section.			
ORDOVICIAN.	*Feet.*		
1. Dark, bluish-black, and gray limestone. In the basal bed immediately above the Cambrian a fine fauna occurs. The limestone is of the same character as that of the Upper Cambrian for 190 feet below, and, except for the change in the fauna, there is no break in the section. One of the characters common to the Cambrian and the superjacent Ordovician is the presence in most layers of flattened concretionary nodules and stringers from a minute size up to 6 or 8 cm. or more in diameter; the large ones rarely exceed 3 to 10 mm. in thickness.		**185z.** *Eoorthis desmopleura*—185z. *Syntrophia nundina*—185z. *Orthoceras*—185z. *Endoceras*—185z. Fragments of trilobites—185z.	**105x?.** *Obolus (Westonia) elongatus*—105x.
UPPER CAMBRIAN.			
St. Charles limestone [Walcott, 1908a, p. 6]: 1. Dark, bluish-gray, and gray limestone in layers varying from 1 to 20 inches in thickness. Many of the layers are almost made up of flattened concretions varying from a minute size to 6 or 8 cm	190	**54b, 54c, 54d.** 25 feet below the top: *Lingulella manticula*—54b. *Eoorthis desmopleura*—54b. *Syntrophia nundina*—54b. *Dicellocephalus*—54b. 105 to 125 feet below the top: *Schizambon typicalis*—54c. *Eoorthis desmopleura*—54c. *Eoorthis newberryi*—54c. *Syntrophia nundina*—54c. *Solenopleura*—54c. *Menocephalus*—54c. *Illaenurus*—54c. 20 to 30 feet above base: *Lingulella (Lingulepis) acuminata*—54d. *Eoorthis desmopleura*—54d. *Eoorthis newberryi*—54d. *Agnostus*—54d. *Solenopleura*—54d. *Menocephalus*—54d. *Asaphus?*—54d.	**54r, 329a.** *Eoorthis desmopleura*—54r. *Syntrophia nundina*—329a.
2*a*. Massive-bedded dark lead-gray arenaceous cliff-forming limestone, becoming thinner bedded in the lower 50 feet.	195		
2*b*. Massive-bedded gray arenaceous limestone with a few irregular cherty layers which extend down 85 feet, just below which the dark arenaceous limestone for a thickness of about 15 feet is almost made up of round concretions 2 to 4 mm. in diameter	100		
2*c*. Gray siliceous and arenaceous limestone in layers one-half inch to 6 inches thick, occurring in massive bands. Light-gray chert fills large and small annelid borings, and it also occurs as flattened stringers in the line of the bedding and in the layers	85	**54j.** *Obolus (Westania) iphis*—54j. *Lingulella desiderata*—54j.	
2*d*. Massive-bedded arenaceous limestone, forming broken cliffs. A few cherty nodules occur near the top, and the lower 50 feet has many irregular oval cherty nodules and stringers of chert coincident with the bedding	397		
	777		

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Utah: Blacksmith Fork, Cache County—Continued.

Blacksmith Fork section. [Walcott, 1908f, pp. 190–200.]		Localities and species in the Blacksmith Fork section.	Other localities and species in Utah and Idaho shown in their approximate stratigraphic position.
UPPER CAMBRIAN—continued.			
St. Charles limestone—Continued.	*Feet.*		
3. Bedded bluish-gray fossiliferous limestone	94	**31m, 31n, 54e, 55h.** Upper part: *Acrotreta* sp.—31n. *Anomocare*—31n. Near base: *Obolus* sp. undt.—31m, 55h. *Lingulella monticula*—31m. *Billingsella coloradoensis*—31m, 55h. *Agnostus*—31m, 55h. *Ptychoparia*—31m, 55h. *Anomocare*—55h. A mixture of the faunas at the base and at the top: *Obolus discoideus*—54e. *Obolus?* sp. undt.—54e. *Lingulella manticula*—54e. *Billingsella coloradoensis*—54e. *Huenella lesleyi*—54e. *Hyolithes*—54e. *Cyrtolites*—54e. *Agnostus*—54e. *Ptychoparia*—54e. *Anomocare*—54e.	**4y, 5a, 5c, 30q, 30s, 54t, 54w, 54x.** *Obolus rotundatus*—30q. *Obolus tetonensis ninus*—54w. *Obolus wortheni*—5a, 5c, 54t, 54w, 54x. *Obolus (Westonia) ella*—4y. *Lingulella desiderata*—5a, 54t. *Lingulella isse*—30s. *Lingulella manticula*—30q. *Acrotreta idahoensis*—5c, 54t. *Acrotreta idahoensis sulcata*—54t. *Billingsella coloradoensis*—4y, 5a, 54t, 54x. *Agnostus*—54w, 54x. *Ptychoparia*—54t, 54w, 54x. *Liostracus*—54w, 54x. *Anomocare*—54t, 54w, 54x. *Damesella* sp.—54w, 54x. *Ptychaspis*—54w, 54x.
4. Bedded light-gray sandstone, followed below by dirty-brown sandstone and toward the base shaly and thin-bedded sandstone	166	**54f, 54g.** In upper 20 feet: *Obolus discoideus*—54f. *Obolus (Fordinia) bellulus*—54f. *Acrotreta idahoensis alta*—54f. *Billingsella coloradoensis*—54f. Near the base: *Lingulella (Lingulepis) acuminata*—54g.	**34q, 54u, 56g.** *Obolus discoideus*—56g. *Obolus mcconnelli pelias*—34q. *Obolus wortheni*—54u. *Acrotreta idahoensis*—54u, 56g. *Acrotreta idahoensis alta*—34q. *Billingsella coloradoensis*—54u, 56g. *Platyceras*—56g. *Agnostus*—54u, 56g. *Ptychoparia*—54u, 56g. *Anomocare*—54u. *Ptychaspis*—54u.
Total Upper Cambrian (St. Charles limestone)	1,227		
MIDDLE CAMBRIAN.			
Nounan limestone [Walcott, 1908a, p. 6]:			
1*a*. Light-gray arenaceous limestone	12	A few traces of fossils occur in the lower 28 feet and large annelid borings occur in many of the arenaceous limestones. In the dark rock the irregular borings are filled with lighter-colored rock, and in the light-gray rock by darker rock.	**56f?.** *Obolus matinalis*—56f. *Lingulella manticula*—56f. *Orthotheca*—56f. *Agraulos*—56f. *Ptychoparia*—56f. *Anomocare*—56f. *Anomocarella*—56f. *Solenopleura*—56f.
1*b*. Lead-colored arenaceous limestone	40		
1*c*. Light-gray arenaceous limestone	85		
1*d*. Dark lead-gray arenaceous limestone	87		
1*e*. Shaly and thin-bedded arenaceous limestone with intercalated reddish-brown sandy layers	15		
1*f*. Light-gray arenaceous limestone	18		
1*g*. Dark lead-gray arenaceous limestone	198		
1*h*. Light-gray arenaceous limestone	494		
1*i*. Dark lead-gray arenaceous limestone, with numerous irregular annelid borings filled with light-gray arenaceous limestone	56		
1*j*. Massive-bedded arenaceous cherty limestone	8		
1*k*. Bluish-gray cherty more or less arenaceous limestone in thick bands that break up into thin layers on weathering	28		
	1,041		
Bloomington formation:		**31l, 54h.**	**33j, 329.**
1*a*. Thin-bedded bluish gray compact limestone with interbedded thick layers of gray limestone	22	*Protospongia* (spicules)—54h. *Obolus mcconnelli pelias*—54h. *Obolus (Westonia) wasatchensis*—54h. *Lingulella desiderata*—31l, 54h. *Hyolithes*—54h. *Agnostus*—31l, 54h. *Ptychoparia*—54h.	*Obolus (Westonia) ella*—329. *Obolus (Westonia) wasatchensis*—33j, 329. *Ptychoparia quadrans*—329. *Olenoides wasatchensis*—329.
1*b*. Greenish argillaceous shale	12		
1*c*. Gray coarse-grained limestone	13	**55m.** *Hyolithes*—55m. *Ptychoparia*—55m.	

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Utah: Blacksmith Fork, Cache County—Continued.

Blacksmith Fork section. [Walcott, 1908f, pp. 190-200.]			Localities and species in the Blacksmith Fork section.	Other localities and species in Utah and Idaho shown in their approximate stratigraphic position.
MIDDLE CAMBRIAN—continued.				
Bloomington formation—Continued.	*Feet.*			
1*d*. Greenish argillaceous and sandy shale	147		**55k.** *Hyolithes* (fragments)—55k. *Agnostus*—55k. *Ptychoparia*—55k.	
1*e*. Gray coarse-grained limestone	4		**54i.** *Micromitra sculptilis*—54i. *Hyolithes* (abundant)—54i. *Ptychoparia*—54i. *Agraulos*—54i.	
1*f*. Greenish argillaceous and sandy shale	22	220		
2*a*. Bluish-gray limestones, with small concretions and small nodules of calcite scattered through the layers, which range from an inch to 6 inches or more in thickness	380		**31j.** Fragments of fossils—31j.	
2*b*. Massive-bedded gray limestone that forms a low cliff and breaks down readily on gentle slopes	132		**55s.** *Ptychoparia*. *Agraulos*. } Same as in 1*e*.	
2*c*. Bluish-gray limestone, with small concretions and small nodules of calcite scattered through the layers; a limestone similar to 2*a*	290		**31i.** *Hyolithes*—31i. *Agraulos*—31i.	
2*d*. Greenish argillaceous shale	39		**54k.** *Obolus* (*Westonia*) *wasatchensis*—54k. *Agraulos*—54k. *Ptychoparia*—54k.	**5h?, 32x, 33t, 54q, 55d?.** *Micromitra* (*Iphidella*) *pannula?*—54q. *Obolus* sp. undt.—54q. *Obolus* (*Westonia*) *ella*—5h. *Obolus* (*Westonia*) *wasatchensis*—32x, 33t, 54q, 55d. *Acrothele subsidua*—54q. *Nisusia alberta*—54q. *Nisusia alberta ?*—54q.
2*e*. Bluish-gray thin-bedded limestone	182			
2*f*. Arenaceous steel-gray limestone	22			
2*g*. Bluish-gray limestone, with small concretions and small nodules of calcite scattered irregularly through the layers	55	1,100	**31h, 55n.** *Micromitra sculptilis*—31h, 55n. *Ptychoparia*—31h, 55n. *Dorypyge*—31h, 55n.	**54v.** *Obolus wortheni*—54v. *Ptychoparia*, 2 species—54v.
Total of Bloomington formation		1,320		
Blacksmith limestone [Walcott, 1908a, p. 7]: 1*a*. Dark lead-gray arenaceous limestone	195			
1*b*. Arenaceous steel-gray cliff-forming limestone, in the lower portion passing gradually into a dove-gray compact limestone that weathers to a light-gray color. The layers vary in thickness from 4 inches to 2.5 feet	375		**31g.** Fragments of a small trilobite (*Ptychoparia ?*)—31g. Annelid borings—31g.	
Total of Blacksmith limestone		570		
Ute limestone [Walcott, 1908a, p. 7]: 1*a*. Bluish-gray compact thin-bedded limestone, with large irregular annelid borings in the upper part filled with steel-gray arenaceous limestone similar to the beds above. Below, the limestone is purer and more uniformly gray and in layers that tend to form low cliffs on the steeper slopes	290		**54m.** In upper part: *Micromitra* (*Paterina*) *labradorica utahensis*—54m. *Billingsella* sp. undt.—54m. *Hyolithes*—54m. *Agraulos*—54m. *Ptychoparia subcoronata*—54m. *Dorypyge ? quadriceps*—54m.	

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Utah: Blacksmith Fork, Cache County—Continued.

Blacksmith Fork section. [Walcott, 1908f, pp. 190–200.]			Localities and species in the Blacksmith Fork section.	Other localities and species in Utah and Idaho shown in their approximate stratigraphic position.
MIDDLE CAMBRIAN—continued.				
Ute limestone—Continued.				
1*b*. Gray arenaceous limestone in thin layers, with a few bands of *Feet.* layers 4 to 10 inches thick, often oolitic, and with interformational conglomerate and flattened concretions	135		**31c, 54o, 55o.** In the upper 5 feet: *Scenella*—55o. *Ptychoparia subcoronata*—55o. *Dorypyge? quadriceps*—55o. In layers 70 to 80 feet below the top: *Micromitra (Paterina) labrodorica utahensis*—54o. *Obolus mcconnelli*—31c. *Acrotreta* cf. *ophirensis*—31c. *Acrotreta* sp. undt.—31c. *Billingsella coloradoensis*—54o. *Otusia utahensis*—31c. *Eoorthis zena*—31c, 54o. *Syntrophia cambria*—31c, 54o. *Hyolithes*—54o. *Scenella*—54o. *Zacanthoides*—31c. *Ptychoparia subcoronata*—31c, 54o. *Dorypyge? quadriceps*—31c, 54o.	**30u, 32e, 32n, 34m.** *Micromitra (Paterina) labradorica utahensis*—30u, 34m. *Obolus (Westonia) ella?*—32n. *Acrotreta* cf. *ophirensis*—30u. *Syntrophia cambria*—32e, 34m.
1*c*. Gray limestone, with numerous concretions one-fourth to one-half inch in diameter. A few thin layers of interformational conglomerate and some shaly limestone	58	483		
2*a*. Gray, fine-grained, calcareous and argillaceous shaly beds	38		**31e, 54a.** *Micromitra (Paterina) labradorica utahensis*—54a. *Obolus (Westonia) ella*—31e, 54a. *Acrothele turneri?*—54a. *Isoxys* cf. *argentea*—54a. *Ptychoparia*—31e, 54a.	**30p, 31z, 32y, 55t, 329c?.** *Micromitra (Paterina) labradorica utahensis*—30p. *Obolus mcconnelli*—30p. *Obolus (Westonia) ella*—30p, 32y, 55t, 329c. *Acrothele subsidua?*—55t. *Acrotreta ophirensis*—31z, 55t.
2*b*. Bluish-gray to blue-black, fine-grained, thin-bedded limestone.	57		*Obolus?*. *Ptychoparia*.	
2*c*. Greenish argillaceous and calcareous shale, weathering buff	51			
2*d*. Thin-bedded grayish-blue limestone	36			
2*e*. Gray oolitic limestone in layers 3 to 14 inches thick	24		**54n.** *Micromitra (Paterina) stuarti*—54n. *Micromitra (Paterina) superba*—54n. *Hyolithes*—54n. *Ptychoparia a*—54n. *Ptychoparia b*—54n. *Dorypyge* (fragment)—54n.	
2*f*. Greenish argillaceous and sandy shale	18		**54p.** *Micromitra (Paterina) superba*—54p. *Obolus mcconnelli*—54p. *Ptychoparia* sp. undt.—54p.	**31y?.** *Obolus mcconnelli*—31y. *Lingulella isse*—31y.
2*g*. Bluish-gray thin-bedded limestone	22	246	**54y.** *Micromitra (Paterina) superba*—54y. *Hyolithes*—54y. *Ptychoparia* (small heads)—54y.	**59g.** *Lingulella* sp.—59g. *Acrothele subsidua*—59g. *Acrotreta* cf. *idahoensis*—59g. *Microdiscus*—59g. *Ptychoparia*, 3 species—59g. *Neolenus*—59g. *Zacanthoides idahoensis*—59g. *Menocephalus*—59g.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Utah: Blacksmith Fork, Cache County—Continued.

Blacksmith Fork section. [Walcott, 1908f, pp. 190–200.]		Localities and species in the Blacksmith Fork section.	Other localities and species in Utah and Idaho shown in their approximate stratigraphic position.
MIDDLE CAMBRIAN—continued.			
Ute limestone—Continued.		**31d, 54l.**	**32c, 32d, 32p, 55c, 55e, 163.**
2*h*. Spence shale member [Walcott, 1908a, p. 8]. (Greenish argillaceous and sandy shale.)	*Feet.* 30	*Micromitra (Iphidella) pannula*—54l. *Obolus (Westonia) ella*—31d, 54l. *Lingulella desiderata*—54l *Hyolithes*—54l. *Orthotheca major*—54l. *Leperditia*—54l. *Ptychoparia*—31d, 54l. *Bathyuriscus productus*—54l.	*Eocystites? longidactylus*—55e. *Micromitra (Paterina) labradorica utahensis*—32d. *Micromitra (Iphidella) pannula*—55c, 55e. *Obolus (Westonia) ella*—32d, 55e. *Lingulella desiderata*—55e. *Acrothele subsidua*—32p, 55c, 55e, 163. *Acrotreta definita*—55c, 163. *Acrotreta idahoensis sulcata*—55c 163. *Acrotreta* cf. *ophirensis*—32c. *Nisusia (Jamesella) nautes*—55c 163. *Nisusia (Jamesella) spencei*—55c 163. *Agnostus*—55c, 55e, 163. *Microdiscus*—55c. *Ptychoparia piochensis*—55e. *Ptychoparia*—55c, 163. *Zacanthoides idahoensis*—55c, 55e 163. *Zacanthoides* sp.—55c. *Neolenus a*—55e. *Neolenus b*—55e. *Olenoides*—55c. *Bathyuriscus howelli*—55e. *Bathyuriscus productus*—55e. *Ogygopsis*—55e. *Oryctocephalus reynoldsi*—55c. *Oryctocara geikiei*—55c. *Hyolithes*—55c.
Total of Ute limestone	759		
Langston limestone [Walcott, 1908a, p. 8]:		(?)	**5b, 54s, 59f, 322, 322a.**
1*a*. Massive-bedded bluish-gray limestone passing downward into gray arenaceous limestone, with many round concretions ¼ to ¾ inch in diameter	64	*Obolus (Westonia) ella.* *Zacanthoides* sp. *Bathyuriscus productus.* *Neolenus?.*	*Micromitra haydeni*—54s. *Micromitra (Iphidella) pannula*—54s, 59f. *Micromitra (Iphidella) pannula maladensis*—54c. *Micromitra (Iphidella) pannula ophirensis*—54s. *Lingulella desiderata*—54s, 59f. *Lingulella helena*—54s. *Lingulella issc*—54s. *Acrothele artemis*—54s. *Acrothele subsidua*—54s. *Acrothele subsidua* var.—54s. *Acrotreta idahoensis sulcata*—54s, 322a. *Acrotreta pyxidicula*—54s, 59f, 322. *Acrotreta?*—54s. *Acrothyra minor*—54s. *Billingsella coloradoensis*—54s. *Hyolithes*—54s. *Orthotheca*—54s. *Stenotheca*—54s, 59f. *Platyceras*—54s. *Agnostus*—54s. *Microdiscus*—54s, 322a. *Solenopleura*—54s, 59f. *Ptychoparia*, 2 species—54s, 59f 322a. *Oryctocephalus*—54s. *Dorypyge*, 2 species—54s. *Neolenus*, 2 species—54s, 59f. *Asaphiscus*—54s. *Ogygapsis?*—54s. *Agraulos*—59f. *Anomocare*—59f. *Zacanthoides*—59f.
1*b*. Massive-bedded bluish-gray limestone that breaks up into layers 2 to 8 inches thick on weathering and with many round concretions	44	**55p.** *Ptychoparia*—55p. *Bathyuriscus productus*—55p.	
	108		
2. Massive-bedded dark arenaceous limestone, passing at about 150 feet down into a calcareous sandstone and then a gray sandstone	390		
Total of Langston limestone	498		
Brigham quartzite [Walcott, 1908a, p. 8]:			
1*a*. Quartzitic sandstone, gray-greenish, gray-brownish, dirty gray, all weathering reddish dirty brown, in layers 3 inches to 3 feet in thickness	28		

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Utah: Blacksmith Fork, Cache County—Continued.

Blacksmith Fork section. [Walcott, 1908f, pp. 190–200.]		Localities and species in the Blacksmith Fork section.	Other localities and species in Utah and Idaho shown in their approximate stratigraphic position.
MIDDLE CAMBRIAN—continued.			
Brigham quartzite—Continued.	*Feet.*	**55r.**	
1*b*. Greenish hard sandy shale	4	Annelid trails—55r. Trilobite tracks—55r.	
1*c*. Same as 1*a* (estimated)	1,200+		
Total of Brigham quartzite	1,232		
Total Middle Cambrian[a]	5,420+		
Total Cambrian	6,647+		

Utah: House Range, Millard County.

House Range section. [Walcott, 1908f, pp. 173–185.]		Localities and species in the House Range section.	Other localities and species in Utah and Nevada shown in their approximate stratigraphic position.
The House Range section lies east and west of Antelope Springs and east-southeast and south of Marjum Pass, House Range, Millard County, Utah. It begins at the top of Notch Peak, the highest point on the House Range south of Marjum Pass.			
ORDOVICIAN.			
Banded thin-bedded bluish-gray and purplish limestone resting conformably on the Cambrian	*Feet.* 285	**105t.** *Obolus* (*Westonia*) *notchensis*—105t. *Eoorthis desmopleura*—105t. *Raphistoma* sp., etc.—105t.	**34g.** *Eoorthis desmopleura*—34g.
UPPER CAMBRIAN.			
Notch Peak limestone [Walcott, 1908a, p. 9];[b]		**31q, 30w, 30x.** *Lingulella isse*—31q. *Dikellocephalus?* sp.?—31q. In drift bowlders: *Eoorthis desmopleura*—30w. *Schizambon typicalis*—30w. *Agraulos*—30w. *Solenopleura*—30w. *Illænurus*—30w. *Crepicephalus*—30x. *Ptychoparia*—30x.	**33l.** *Eoorthis desmopleura*—33l. *Solenopleura*—33l. *Illænurus?*—33l.
1*a*. Gray arenaceous limestone in thick layers and bands of thin layers. Irregular nodules and thin layers of dark-gray chert weathering dark brown occur at irregular intervals for 350 feet below the summit. A few thin cherty layers ½ to ⅛ inch thick also occur below	640		
1*b*. Shaly dark-gray to bluish-gray arenaceous limestone, with small dark concretions in some layers	90		
1*c*. Gray siliceous limestone in layers of varying thickness, 4 inches to 2 feet, banded with dark cherty layers and purer arenaceous limestone. The chert takes the form of flattened nodules and very thin irregular layers	340		
1*d*. Shaly and thin-bedded bluish gray arenaceous limestone	65		
1*e*. Gray siliceous limestone in layers 2 inches to 2 feet thick. The lower part, where not metamorphosed, is dove-colored and in layers 6 inches to 3 feet thick, with some gray cherty matter in flattened nodules and thin layers that weather a dark brown	355	**30m.** *Obolus tetonensis leda*—30m. Fragments of the free cheek of a trilobite—30m.	
Total of Notch Peak limestone	1,490		
Orr formation [Walcott, 1908a, p. 10];[c]			
1*a*. Bluish-gray to gray compact limestone in layers 1 inch to 2 feet thick. On weathering, the thicker layers break down into thin irregular layers which form a talus of angular fragments	375	Fragments of trilobites.	
1*b*. Sandy and siliceous bluish and drab-colored shales, with interbedded bands of dark bluish-gray limestone 6 inches to 2 feet thick	84	**30l, 30y.** Section of crinoid column—30l. *Obolus rotundatus*—30y. *Lingulella isse*—30y. *Lingulella manticula*—30l. *Anomocare*—30l, 30y. *Ptychaspis*—30l.	**32f.** *Lingulella manticula*—32f. *Lingulella perattenuata*—32f. *Lingulella pogonipensis*—32f

[a] The line of separation between the Middle and Lower Cambrian occurs somewhere in the Brigham quartzite, and this thickness (5,420 feet) probably includes several hundred feet of Lower Cambrian beds.

[b] Section exposed on the east and southeast slopes and ridges of Notch Peak.

[c] The section is carried along the strike of the exposed strata 2 miles east to the west side of Orr Ridge, where the rocks of the Orr formation are unmetamorphosed.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Utah: House Range, Millard County—Continued.

House Range section. [Walcott, 1908f, pp. 173-185.]			Localities and species in the House Range section.	Other localities and species in Utah and Nevada shown in their approximate stratigraphic position.
UPPER CAMBRIAN—continued.				
Orr formation—Continued.		*Feet.*		
1c. Lead-colored finely oolitic and arenaceous limestone in layers 4 inches to 2 feet thick, obscurely banded by thin strips of light and dark gray color	91		Fragments of trilobites.	
1d. Bluish-gray compact limestone in layers 2 inches to 4 feet thick that break down into irregular thin layers on weathering	115		**31t.** *Linnarssonella modesta*—31t. *Linnarssonella nitens*—31t. *Solenopleura*—31t.	
1e. Dirty-brown and bluish-black arenaceous shales, with thin nodules of gray fossiliferous limestone in some horizons; also a few layers of bluish-gray limestone 4 inches to 8 inches thick	235	900	**30j, 30k.** *Micromitra (Paterina) crenistria?*—30j. *Obolus mcconnelli pelias*—30j. *Lingulella desiderata*—30j. *Lingulella isse*—30j, 30k. *Linnarssonella modesta*—30k. *Linnarssonella transversa*—30j. *Agnostus*—30j. *Crepicephalus*—30j. *Ptychoparia?*—30k. *Solenopleura*—30k.	**15d, 32g, 32t, 33d, 33n?, 34i, 34r, 34t, 329d?.** *Obolus mcconnelli pelias*—32g, 33d. *Obolus rotundatus*—33d, 34i, 34r. *Lingulella desiderata*—15d, 32g, 34i. *Lingulella isse*—15d, 32g, 33d, 34r, 34t. *Lingulella monticula*—15d. *Schizambon typicalis*—33d. *Linnarssonella girtyi*—32t. *Linnarssonella niteus*—32g. *Acrotreta idahoensis*—15d. *Acrotreta idahoensis alta*—15d, 33n. *Acrotreta marjumensis*—33d. *Acrotreta pyxidicula*—329d. *Agnostus*—33d, 34t. *Agraulos*—33d. *Menocephalus*—32g. *Ptychoparia*—34t. *Ptychoparia?* sp.—32g, 33d, 34r. *Solenopleura*—32g, 34t. *Ptychaspis*—32t.
2a. Gray slightly arenaceous cliff-forming limestone in layers 2 to 6 feet thick, weathering lead gray	590		**30h, 30i.** *Lingulella desiderata*—30h. *Acrotreta idahoensis*—30h. *Agraulos*—30i. *Crepicephalus texanus*—30h. *Bathyuriscus*—30h. *Illænurus??*—30h.	
2b. Gray limestone and dark-gray chert in alternating layers ½ to 2 inches thick. The irregular cherty layers weather in relief as dark-brown bands and the limestone as lead-colored bands, which give a very characteristic banded appearance to the cliff	170			
2c. Gray arenaceous limestone in massive beds that usually break up, on weathering, into irregular layers ½ to 4 inches thick. The upper 20 feet form a more massive solid bed than the layers below	165	925	Traces of trilobites and brachiopods.	
Total of Orr formation		1,825		
Total Upper Cambrian		3,315		
MIDDLE CAMBRIAN.				
Weeks limestone [Walcott, 1908a, p. 10]:[a]				
1a. Thin-bedded limestones in layers 1 to 4 inches thick. The limestone is mainly fine grained, dark gray, and weathers lead colored, except on bedding planes, where it is usually more or less pinkish	245		Fragments of trilobites and brachiopods of the fauna in shaly limestone in 1b.	
1b. Shaly limestone, usually dark gray, with pinkish tinge in some layers and on the surfaces; sometimes buff yellow on weathering. The shales vary from ⅛ to 1 inch thick. This is a marked band in some sections and is arbitrarily separated from the shaly beds below	285		**30o.** The fauna ranges through about 100 feet of the lower portion of this division. *Obolus (Fordinia) perfectus*—30o. *Agnostus*, 2 species—30o. *Ptychoparia*—30o. *Crepicephalus texanus*—30o. *Anomocare*—30o. *Bathyuriscus*—30o. *Asaphiscus* sp.—30o. *Solenopleura*—30o.	

[a] Section exposed at Weeks Canyon from beneath the massive limestone on the south side of the canyon to the top of the cliffs on the south side of Marjum Pass. Average dip, 12°; strike, N. 20° E. (magnetic).

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Utah: House Range, Millard County—Continued.

House Range section. [Walcott, 1908f, pp. 173–185.]		Localities and species in the House Range section.	Other localities and species in Utah and Nevada shown in their approximate stratigraphic position.
MIDDLE CAMBRIAN—continued.			
Weeks limestone—Continued.			
1c. Shaly bluish-gray to dark-gray limestone in layers ¼ to 1 inch thick, with occasional layers 2 to 6 inches thick; 25 feet from the top a band of layers of arenaceous dirty-gray finely oolitic limestone 3 feet thick occurs, and a second similar band 38 feet below	*Feet.* 170	**30n, 30n′.** *Lingulella isse*—30n, 30n′. *Obolus (Fordinia) perfectus*—30n, 30n′. *Acrotreta ophirensis*—30n, 30n′. *Acrotreta ophirensis descendens*—30n, 30n′. *Hyolithes*—30n, 30n′. *Agnostus* (several species)—30n, 30n′. *Ptychoparia* (several species)—30n, 30n′. *Crepicephalus texanus*—30n, 30n′. *Solenopleura*—30n, 30n′. *Asophiscus* sp.—30n, 30n′. *Nolenus*—30n, 30n′.	
1d. Reddish-tinted more or less arenaceous shaly limestone	30	Same as 1c, but not abundant.	
1e. Shaly bluish-gray to dark-gray limestone, similar to 1c	270	Same as that of 1c.	
1f. Evenly bedded bluish-gray to dark-gray fine-grained limestone, in layers 2 to 16 inches thick, with shaly limestone partings	330	A few traces of *Agnostus* and *Ptychoparia* similar to those above.	
1g. Calcareous shales with thin layers of limestone	60		
Total thickness of Weeks limestone	1,390		
Marjum limestone [Walcott, 1908a, p. 10]:[a]			
1a. Gray, more or less thin-bedded limestone that weathers dark lead gray and breaks down into angular fragments ½ to 2 inches thick. Flattened cherty nodules and thin irregular cherty layers occur at intervals	305	**10y, 10z, 11n, 11o.** In upper 100 feet: *Obolus mcconnelli pelias*—11n. *Obolus (Fordinia) gilberti*—11n. *Acrotreta bellatula*—11n. *Acrotreta marjumensis*—11n. *Acrotreta* cf. *sagittalis*—11n. *Agnostus*, 4 species—11n. Central portion: *Micromitra sculptilis*—10y. *Lingulella arguta*—10y. *Dicellomus prolificus*—10z. *Acrotreta attenuata*—10y. *Acrotreta bellatula*—10z. *Agnostus*—10y, 10z. *Ptychoparia*—10y, 10z. *Anomocare*—10y, 10z. Near base: *Micromitra (Iphidella) pannula ophirensis*—11o. *Obolus mcconnelli pelias*—11o. *Obolus rotundatus*—11o. *Hyolithes*—11o. *Stenotheca*—11o. *Ptychoparia*—11o. *Anomocare*—11o. *Bathyuriscus*—11o.	**15p, 15x, 34v, 329b?.** *Obolus mcconnelli pelias*—15p, 15x, 34v. *Lingulella desiderata*—15p, 15x. *Dicellomus politus*—329b. *Ptychoparia*—34v.
1b. Alternating bands of dark blue-gray compact limestone in massive layers that break up into thin irregular layers, and gray arenaceous limestone in layers 1 to 8 inches thick. 1. Gray limestone 35 2. Blue-gray limestone 7 3. Gray arenaceous limestone 95 4. Blue-gray limestone 12 5. Gray arenaceous limestone 90 6. Blue-gray limestone 8	247	*Ptychoparia* sp. undt.	

[a] Section exposed in the cliffs southeast of Marjum Pass and in the ridge east of Wheeler Amphitheater.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Utah: House Range, Millard County—Continued.

House Range section. [Walcott, 1908f, pp. 173-185.	Localities and species in the House Range section.	Other localities and species in Utah and Nevada shown in their approximate stratigraphic position.
MIDDLE CAMBRIAN—continued.		
Marjum limestone—Continued. *Feet.* 1c. Dark and light-gray thin-bedded limestone, more or less arenaceous..... 250	**3w, 11q, 11y, 30g, 30z.** Near top: *Acrotreta pyxidicula*—30z. *Agnostus*—30z. *Ptychoparia* like *P. kingi*—30z. In central portion, though ranging through 100 to 150 feet of the thin-bedded shaly limestone: *Obolus mcconnelli pelias*—11q, 30g. *Lingulella arguta*—3w, 11q, 11y. *Acrothele subsidua*—11q, 30g. *Acrotreta ophirensis?*—11y, 30g. *Nisusia (Jamesella) nautes*—11q. *Nisusia (Jamesella) spencei*—11q. *Eoorthis thyone*—11q. *Hyolithes*—30g. *Agnostus*, 2 species—30g. *Ptychoparia*, 3 species—30g. *Solenopleura*—30g. *Neolenus inflatus*—11q, 30g. *Neolenus intermedius*—11q, 30g. *Neolenus intermedius pugio*—11q, 30g. *Neolenus superbus*—11q, 30g. *Ogygopsis?*—11q, 30g.	**7w, 14v?, 15c, 32k, 34s?.** *Obolus mcconnelli*—14v, 32k, 34s. *Nisusia (Jamesella) nautes*—15c. *Nisusia (Jamesella) utahensis*—7w. *Anomocare*—15c. *Ptychoparia*—32k.
1d. Gray shaly limestone passing below into shales interbedded in the shaly limestone, and at 75 feet from the top into drab argillaceous shales..... 105	**3x, 3y, 8i, 11x.** *Micromitra (Iphidella) pannula ophirensis*—3x. *Micromitra sculptilis*—3x, 8i. *Obolus mcconnelli pelias*—3x, 8i. *Obolus rotundatus*—3x, 11x. *Lingulella arguta*—3x, 11x. *Acrotreta attenuata*—3x. *Acrotreta ophirensis*—3x, 3y. *Acrothele subsidua*—3x. *Acrothele subsidua lævis*—3x. *Eoorthis remnicha*—3x. *Eoorthis thyone*—3x. *Syntrophia unxia*—3x. *Agnostus*, 3 species—3x. *Ptychoparia*—3x. *Neolenus inflatus*—3x. *Neolenus intermedius*—3x. *Neolenus superbus*—3x. *Ogygopsis?*—3x.	**3e.** *Micromitra (Iphidella) pannula ophirensis*—3e. *Micromitra* sp.—3e. *Obolus matinalis*—3e. *Obolus tctonensis*—3e. *Lingulella arguta*—3e. *Acrothele subsidua lævis*—3e. *Acrotreta ophirensis*—3e. *Acrotreta ophirensis rugosa*—3e. *Ptychoparia*—3e. *Neolenus* sp.—3e. *Agnostus* sp.—3e.
1e. Dark bluish-gray limestone in thick beds that break up on weathering into thin, irregular layers ½ to 2 inches thick..... 195 Total thickness of Marjum limestone..... 1,102	**11p.** Sponge spiculæ—11p. *Linnarssonella* sp.—11p. *Agnostus*—11p. *Ptychoparia*—11p. *Ogygopsis*—11p.	
Wheeler formation [Walcott, 1908a, p. 10]:[a] 1. Alternating bands of thin shaly limestone and calcareous shale, with shale gradually increasing and predominating toward the lower portion. At 405 feet from top a band of blue-gray hard limestone, in layers ½ to 2 inches thick, occurs. At 473 feet another band, and below an occasional thin layer..... 570	**3s, 3t, 4, 8g, 11u, 15b.** *Obolus mcconnelli pelias*—3s, 3t, 8g. *Acrothele subsidua*—3s, 3t, 4, 8g, 11u, 15b. *Acrotreta attenuata*—3s, 3t, 8g. *Agnostus bidens*—3s, 3t, 8g. *Asaphiscus wheeleri*—3s, 3t, 8g. *Ptychoparia kingi*—3s, 3t, 8g.	**8k?.** *Obolus mcconnelli pelias*—8k.

[a] Section exposed at Marjum Pass, but the type locality is in Wheeler Amphitheater, southeast of Antelope Springs. The section was measured south from the ridge south of the lower springs of Antelope Springs.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Utah: House Range, Millard County—Continued.

House Range section. [Walcott, 1908f, pp. 173–185.]			Localities and species in the House Range section.	Other localities and species in Utah and Nevada shown in their approximate stratigraphic position.
MIDDLE CAMBRIAN—continued.				
Swasey formation [Walcott, 1908a, p. 11]: [a]		*Feet.*		
1*a*. Oölitic and arenaceous limestone in massive layers near the top. Below, some dark bluish-gray limestone is interbedded, and gradually it becomes the principal rock; it breaks up on weathering into irregular shaly layers ½ to 3 inches thick	152		**30b, 31w.** Near the top: *Platyceras*—31w. *Zacanthoides*—31w. Near the base: *Scenella*—30b. *Zacanthoides*—30b. *Ptychoparia*—30b. *Dorypyge*—30b.	
1*b*. Drab and reddish argillaceous shales, with interbedded thin layers of fossiliferous limestone	63			
1*c*. Dark bluish-gray limestone in massive layers that break up into irregular shaly layers ¼ to 2 inches thick	17			
1*d*. Calcareous and argillaceous shales, with thin layers of gray limestone	102		**11w, 30c.** *Micromitra* (*Paterina*) *labradorica utahensis*—30c. *Lingulella arguta*—11w. *Ptychoparia*, 2 species—11w, 30c.	
1*e*. Bluish-gray limestone in layers 4 to 10 inches thick, with numerous concretions from ⅛ to 1 inch in diameter in a few layers	6		**30d.** *Obolus* (*Westonia*) *ella*—30d. *Ptychoparia*, 3 species—30d.	**34u?.** *Obolus* (*Westonia*) *wasatchensis*—34u.
Total of Swasey formation		340		
Dome Canyon limestone [Walcott, 1908a, p. 11]: [b] Massive-bedded cliff-forming gray siliceous limestone, with small specks of calcite. 100 feet from the top and for 50 feet below some layers of brownish-yellow arenaceous limestone 15 inches to 2 feet thick occur		355		
Howell formation [Walcott, 1908a, p. 11]: [c]				
1*a*. Bluish-black limestone in massive layers that break up on weathering into irregular thin layers	50		**31v.** *Micromitra* (*Iphidella*) *pannula*—31v. *Acrotreta* cf. *ophirensis*—31v. *Ptychoparia*—31v.	**14t?, 33r?.** *Micromitra* (*Iphidella*) *pannula*—14t. *Lingulella* cf. *similis*—14t. *Acrotreta neboensis*—14t. *Otusia utahensis*—33r.
1*b*. Gray siliceous limestone	8			
1*c*. Bluish-black limestone similar to 1*a*	105			
1*d*. Pinkish-colored argillaceous shale, with interbedded thin layers of limestone	10		**31s.** *Micromitra* (*Iphidella*) *pannula*—31s. *Obolus* (*Westonia*) *ella*—31s. *Acrotreta* cf. *ophirensis*—31s. *Scenella*—31s. *Hyolithes*—31s. *Zacanthoides*—31s. *Bathyuriscus*—31s.	**3d, 11s, 32h, 32j, 32z, 33f.** *Micromitra sculptilis*—11s. *Micromitra* sp.—3d. *Micromitra* (*Paterina*) *labradorica utahensis*—3d. *Obolus* (*Westonia*) *ella*—3d, 11s, 32h, 32z. *Obolus* (*Westonia*) *ella onaquiensis*—33f. *Acrotreta* cf. *ophirensis*—32j. *Olenoides?*—3d. *Bathyuriscus* sp.—32h, 32z.
1*e*. Gray siliceous limestone in layers 2 to 10 inches thick	70			
1*f*. Bluish-black limestone in massive layers, breaking up into thin layers on weathering	102		**30f.** *Ptychoparia*—30f. *Bathyuriscus*—30f.	

[a] Section exposed on the southwest ridge of Swasey Peak.
[b] Section exposed in the central portion of Dome Canyon and adjoining cliffs.
[c] Section exposed on the west face of the House Range at Howell Mountain.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Utah: House Range, Millard County—Continued.

House Range section. [Walcott, 1908f, pp. 173–185.]		Localities and species in the House Range section.	Other localities and species in Utah and Nevada shown in their approximate stratigraphic position.
MIDDLE CAMBRIAN—continued.			
Howell formation—Continued.	*Feet.*		
1*g*. Gray siliceous limestone in thick beds	90		**55u?.** *Micromitra (Iphidella) pannula*—55u. *Linnarssonella urania*—55u.
1*h*. Pinkish argillaceous shale, which is believed to be the same as the Spence shale member of the Ute limestone of northeastern Utah, is exposed on the east side of Dome Canyon a little above where it bends to the westward	20	**3v.** *Micromitra (Iphidella) pannula*—3v. *Obolus (Westonia) ella*—3v. *Lingulella dubia*—3v. *Acrothele subsidua*—3v. *Hyolithes billingsi*—3v. *Ptychoparia piochensis*—3v. *Ptychoparia* sp.—3v. *Zacanthoides typicalis*—3v. *Bathyuriscus productus*—3v.	**3c, 7k, 30a, 31, 31u, 32o, 34n?, 329e, 333, 333a, 333b.** *Micromitra (Iphidella) pannula*—30a, 31, 333. *Obolus mcconnelli*—34n. *Obolus (Westonia) ella*—3c, 30a, 31, 31u, 32o, 329e, 333, 333a, 333b. *Lingulella dubia*—31, 333. *Lingulella helena*—30a. *Hyolithes billingsi*—30a, 31, 31u. *Isoxys argentea*—30a. *Eocystites longidactylus*—31, 31u, 333. *Ptychoparia kempi*—333b. *Ptychoparia piochensis*—31, 31u, 333a, 333b. *Ptychoparia quadrans*—30a. *Anomocare parvum*—31. *Bathyuriscus howelli*—31, 31u, 333, 333a, 333b. *Bathyuriscus productus*—30a, 31, 31u, 333, 333a. *Zacanthoides grabaui*—333b. *Zacanthoides typicalis*—31, 31u, 333, 333b.
Total of Howell formation	455		
Langston (?) limestone [Walcott, 1908a, p. 8]: [a]			
1*c*. Massive-bedded bluish-gray arenaceous limestone, with irregular partings of buff-colored arenaceous limestone. The latter penetrates the layers of limestone in the most irregular manner and frequently surrounds small irregular nodules of the bluish-gray limestone	170	**30e.** *Billingsella* sp. undt.—30e. *Platyceras*—30e. *Hyolithes*—30e. *Leperditia*—30e. *Ptychoparia*—30e. *Zacanthoides*—30e. *Dorypyge?*—30e.	
1*b*. Brown buff-weathering arenaceous limestone in thick layers; almost sandstone in places	35		
Total of Langston (?) limestone	205		
Total Middle Cambrian	4,417		
LOWER CAMBRIAN.			
Piache formation [Walcott, 1908a, p. 11] [b] Arenaceous and siliceous shaly layers, with some thicker layers of quartzitic sandstone	125	Annelid trails. Trilobite tracks (*Cruziana*).	**4l, 30, 31a, 33i, 313g.** *Micromitra (Iphidella) pannula*—4l, 30, 31a. *Obolus (Westonia) ella*—33i. *Acrothele spurri*—31a. *Acrothele subsidua hera*—31a. *Acrotreta claytoni*—4l. *Acrotreta primæva*—4l, 31a. *Billingsella highlandensis*—30, 31a. *Billingsella* sp.—313g. *Nisusia (Jamesella) erecta*—313g. *Hyolithes billingsi*—31a. *Callavia nevadensis*—30, 313g. *Olenellus fremonti*—30, 313g. *Olenellus gilberti*—30, 31a. *Peachella iddingsi*—30, 313g. *Zacanthoides levis*—31a. *Crepicephalus augusta*—30, 31a. *Crepicephalus liliana*—30, 31a. *Oryctocephalus primus*—31a.
Prospect Mountain quartzite [Walcott, 1908a, p. 12]: [c] Gray and brownish quartzitic sandstone in layers 4 inches to 3 feet in thickness	1,375+		
Total Lower Cambrian	1,500+		
Total Cambrian	9,232		

[a] This section of beds which are doubtfully referred to the Langston was measured at the same locality as the shale forming 1*h* of the Howell formation, which is believed to be equivalent to the Spence shale member of the Ute limestone of northeastern Utah.

[b] Section exposed at the westward bend of Dome Canyon.

[c] Section exposed on the west slope and foothills of the House Range north and south of Dome Canyon.

Detailed stratigraphic distribution of Cambrian and Ordovician Brachiopoda—Continued.

Vermont.

The localities in Vermont are somewhat scattering, but most of them are confined to a fairly well-marked horizon in the Lower Cambrian. Two (**319f** and **227**) occur in the Ordovician, four (**28**, **16n**, **87′**, and **319q**) in the Upper Cambrian, and two (**28a** and **319s**) in the Middle Cambrian. The interrelations of these localities (see index for numbers) are obscure and stratigraphic comparisons would have little value.

Virginia and Maryland.

All but two of the localities in Maryland and Virginia (see index for numbers) occur in the same Lower Cambrian sandstone horizon. One Upper Cambrian locality (**92b**) and one Middle (**47h**) have been identified.

Wales.

See England, Scotland, and Wales, where the different horizons are more or less closely differentiated and correlated, with complete lists of localities and included species.

Wisconsin, Michigan, Minnesota, and Iowa.

Two localities (**339** and **364a**) from the Lower Ordovician Oneota dolomite and three (**328b**, **339a**, and **364**) from the Upper Cambrian St. Lawrence formation have been identified by Sardeson [1896, pp. 95 and 96]. The remainder are from the "St. Croix sandstone," and have all been referred to the Upper Cambrian, with the following exceptions: **79x**, **83[4]**, **84**, **84f**, **84s**, **328e**, **328g**, **339e**, **339i**, **339j**, and **339k**. These eleven localities occur in the lower portion of the "St. Croix sandstone" and while they may belong in the Upper Cambrian, they have been placed in the Middle Cambrian because of the entire absence in the collections at our disposal of characteristic Upper Cambrian forms.

Wyoming.

See both South Dakota and Montana for general discussion of stratigraphy.

HABITAT.

The conditions in which the Cambrian brachiopods are found indicate that some of them were gregarious in habit, and that many persisted through marked changes of environment and sedimentation. *Micromitra* (*Iphidella*) *pannula*, for instance, is found in sandstone, siliceous and argillaceous shale, and limestone. It has a wide distribution in the Cordilleran province of western North America, and has a vertical range of 2,000 feet or more. Other forms, such as *Micromitra haydeni*, are known only from one locality and one layer of rock. A large number of species occur in sandstone and shales that are evidently of shallow-water origin; others occur in limestones that were probably deposited in relatively deep water. The evidence indicates that their habitat largely ranged from between tides to a depth of 1,000 to 2,000 feet. Some forms may have had a greater bathymetric range, but the evidence in favor of such a conclusion is not known to me.

In the following list there has been brought together a summary statement of the character of the sediment in which each of the genera taken up in this monograph occurs. Gradations from one type of sediment to another are so frequent and close that some of the separations may be considered arbitrary, though most of the determinations have been made by an examination of the hand specimen upon which the species is preserved. The numbers in the columns give the number of species occurring in the different classes of sediment and the number which have been identified from more than one class. The totals at the end of the table give the number of species and the number of genera, respectively, that have been identified from the different sediments.

It is probable that a reexamination of some of the specimens would justify their transfer to another column; for instance, the one sandstone representative of the genus *Huenella* might be found to occur in a calcareous sandstone or arenaceous limestone, which might equally as well be placed in the limestone column; but the table as a whole and the figures for each genus seem to indicate that the various genera are by no means confined to nor even characteristic of a given type of sediment. On the other hand, a similarly prepared table of the species in the monograph showed that with few exceptions each of the species is confined to one type of sediment. Disregarding those species (about 200) which have been found at but one locality, the table showed that out of over 500 specific occurrences only 150 had been identified from more than one type of sediment. Errors in the identification of sediment would be of more importance in the latter case than in that of the genera, but none of the specimens were reexamined and in none of the tables has there been any rearrangement of the figures.

List of genera and subgenera, alphabetically arranged, giving number of species occurring in the different types of sediment.

Genera.	Limestone.	Shale.	Sandstone.	Limestone and sandstone.	Limestone and shale.	Shale and sandstone.	All three.
Acrothele	17	28	9		8	4	1
(Redlichella)	1						
Acrothyra	1	2	4			2	
Acrotreta	47	26	15	3	12	2	2
Bicia	2						
Billingsella	15	5	9	3	1		2
Botsfordia	2	1	2	1			
Clarkella	1						
Curticia			1				
Dearbornia	1						
Delgadella		1					
Dicellomus	6	3	4	2	1		2
Discinolepis			1				
Discinopsis	1		1				
Elkania	2	1					
Eoorthis	23	9	9	4	2		
Eostrophomena	1						
Finkelnburgia			3				
Helmersenia			1				
Huenella	8		1	1			
Keyserlingia			1				
Kutorgina	4	3	2		2	1	
Lingulella	35	36	48	6	7	6	6
(Leptembolon)			1				
(Lingulepis)	5	7	10	1		3	1
Linnarssonella	7	4	3	1	2		2
Mickwitzia			5				
Micromitra	9	5	2	1	3		1
(Iphidella)	5	3	2			1	1
(Paterina)	13	10	8	2	2		4
Neobolus			1				
Nisusia	5	3	3				2
(Jamesella)	10	3	4		3		
Obolella	6	3	8	2		1	1
(Glyptias)			1				
Obolus	35	18	30	5	5	1	3
(Acritis)	2		1	1			
(Bröggeria)	1	1	1				1
(Fordinia)	3		1	1			
(Lingulobolus)	2		2	2			
(Mickwitzella)			1				
(Palæobolus)		2	2			2	
(Schmidtia)			4				
(Westonia)	8	6	14	2	1	1	1
Orbiculoidea		2	3			2	
Orusia	4	1	1				1
Otusia	2		1	1			
Philhedra	1						
Protorthis	2	5	2				1
(Loperia)			1				
Quebecia	1						
Rustella		1	2			1	
Schizamhon	2	1	2	1			
Schizopholis			1				
Schuchertina	1						
Siphonotreta	2	1					
Swantonia		2	1			1	
Syntrophia	10		5	3			
Trematobolus	1	1	4			1	
Volborthia	1						
Wimanella	2	4	1		1		
Wynnia		1					
Yorkia	3		1	1			
Genera	44	33	50	21	14	14	18
Species	310	199	240	44	50	28	33

LOCALITIES.

The following list gives all known data concerning all localities from which fossils described in this paper have been obtained. After most of them reference is given to the pages on which their stratigraphic position is shown (pp. 124–159). Those that are without references are more or less isolated places for which stratigraphic data are lacking and which are without near neighbors to which they may be profitably compared. An asterisk (*) placed before the name of a species indicates that the place from which it is cited is its type locality. In localities 1–227 and C1–C75 the Brachiopoda are not accompanied by author names, but for purposes of identification the author names follow all other listed species. In localities 300 to 396z all the listed species are accompanied by a reference to either the place of citation or the museum in which the specimens are located. In all lists the Brachiopoda are placed first.

Numbers 1–227 were assigned to the different localities represented in the United States National Museum at the time of their accession and indicate distinct faunules. Numbers

C1–C75 (pp. 286–291) were assigned to the faunules collected by the expedition to China of the Carnegie Institution of Washington. Numbers 300–396z (pp. 229–286) have been arbitrarily assigned to localities mentioned in the literature or unnumbered localities in the United States National Museum collections, and the included species may not occur together as do those of the former localities. For each of the species listed in localities 300–396z it is simply true that the description of the locality under which it is placed gives all available information as to its stratigraphic and geographic position and the authority for so listing it.

Localities 1–227, U. S. National Museum.

1 (about 50 feet above 1a). (For stratigraphic position and association, see p. 140.) Middle Cambrian: Shales of zone A of No. 7 of the Manuels Brook section [Walcott, 1891b, p. 261], Manuels Brook, a small stream which flows into Conception Bay from the east, near Topsail Head, Newfoundland (C. D. Walcott, 1888).

*Obolus fragilis.	Conocoryphe matthewi (Hartt).
Lingulella ferruginea.	Paradoxides hicksi Salter.
Lingulella ferruginea?.	Paradoxides sp.
Acrothele matthewi.	Anopolenus venustus Billings.
Acrotreta misera.	Erinnys venulosa Salter.

Walcott [1891b, p. 261] cites the following additional species:

Hyolithes sp. a.	Conocoryphe elegans (Hartt).
Agnostus 3 sp.	Agraulos socialis Billings.
Microdiscus punctatus Salter.	Liostracus tener (Hartt).

1a (=6n and 6 l, about 50 feet below 1). (For stratigraphic position and association, see p. 140.) Middle Cambrian: Shales near the top of No. 6 of the Manuels Brook section [Walcott, 1891b, p. 261], Manuels Brook, Conception Bay, Newfoundland (C. D. Walcott, 1888).

Obolus fragilis.	Liostracus tener (Hartt).
Lingulella ferruginea.	Conocoryphe elegans (Hartt).
Acrothele matthewi.	Paradoxides davidis Salter.
Agraulos socialis (Billings).	Paradoxides sp.

1l (same horizon as 1v). (For stratigraphic position and association, see p. 138.) Lower Cambrian: Shales of No. 3 of the Silver Peak group, Barrel Spring section [Walcott, 1908f, p. 189[a]], 2.5 miles (4 km.) south of Barrel Spring and 0.5 mile (0.8 km.) east of road, in the extreme southeastern corner of the Silver Peak quadrangle (U. S. G. S.), Esmeralda County, Nev. (F. B. Weeks, 1899).

Acrothele spurri?.	Ptychoparia sp.
Acrotreta claytoni.	Olenellus gilberti Meek.

1m (=1p). (For stratigraphic position and association, see p. 138.) Lower Cambrian: Limestones of No. 2 of the Silver Peak group, Barrel Spring section [Walcott, 1908f, p. 189], about 2.5 miles (4 km.) south of Barrel Spring and 0.5 mile (0.8 km.) east of the road, in the extreme southeastern corner of the Silver Peak quadrangle (U. S. G. S.), Esmeralda County, Nev. (F. B. Weeks, 1899).

Micromitra (Paterina) prospectensis.	Olenellus gilberti Meek.
Nisusia (Jamesella) argenta.	

1p (=1m, which see). (For stratigraphic position and association, see p. 138.) (F. B. Weeks, 1899.)

Micromitra (Paterina) prospectensis.	Olenellus fremonti Walcott.
*Nisusia (Jamesella) argenta.	Olenellus gilberti Meek.

1v (same horizon as 1 l). (For stratigraphic position and association, see p. 138.) Lower Cambrian: Shales of No. 3 of the Silver Peak group, Barrel Spring section [Walcott, 1908f, p. 189[a]], 3 miles (4.8 km.) north of Valcalda Spring and 4 miles (6.4 km.) west-northwest of the Drinkwater mine, Silver Peak quadrangle (U. S. G. S.), Esmeralda County, Nev. (F. B. Weeks, 1899).

Archæocyathus.	Swantonia sp.
*Micromitra (Paterina) labradorica var.	Stenotheca cf. elongata Walcott.
Kutorgina cingulata.	Stenotheca cf. rugosa (Hall).
*Kutorgina perugata.	Ptychoparia sp.
*Siphonotreta? dubia.	Wanneria gracile Walcott.
*Swantonia weeksi.	Olenellus argentus Walcott.

2. (For stratigraphic position and association, see p. 140.) Middle Cambrian: Shales of zone B of No. 7 of the Manuels Brook section [Walcott, 1891b, p. 261], Manuels Brook, Conception Bay, Newfoundland (C. D. Walcott, 1888).

Obolus fragilis.	Acrothele matthewi.
Lingulella ferruginea.	

[a] The species mentioned by Walcott [1908f, p. 189] occur at slightly different localities (1l and 1v), none of the species being common to both localities.

Walcott [1891b, p. 261] cites the following:

Linnarssonia misera=Acrotreta misera.
Orthis sp.
Stenotheca sp.
Agnostus punctuosus Angelin.
Agnostus 5 sp.
Microdiscus punctatus Salter.
Paradoxides davidis Salter.
Paradoxides hicksi Salter.
Paradoxides sp.
Anopolenus venustus Billings.
Conocoryphe elegans (Hartt).
Ctenocephalus matthewi (Hartt).
Erinnys venulosa Salter.
Ptychoparia robbi Hartt.
Ptychoparia variolaris Salter.
Holocephalina inflata Hicks.
Agraulos socialis Billings.

2a (same horizon as 1). (For stratigraphic position and association, see p. 140.) Middle Cambrian: Above and to the north of the limestone, in the shales of the *Paradoxides* zone, Topsail Head, Conception Bay, Newfoundland (C. D. Walcott, 1888).

Lingulella ferruginea.

2b. Lower Cambrian: Limestone just north of Beman Park, in the northeastern part of the city of Troy, Troy quadrangle (U. S. G. S.), Rensselaer County, N. Y. (H. E. Dickhaut, 1899).

Micromitra (Paterina) labradorica.
Bicia gemma.
*Bicia whiteavesi.
Obolella crassa.
Botsfordia cælata.
Billingsella salemensis.

2d. Lower Cambrian: Arenaceous limestone in the knobs just east of Beman Park and southwest of Brunswick, near Troy, Troy quadrangle (U. S. G. S.), Rensselaer County, N. Y. (H. E. Dickhaut, 1899).

Obolella crassa.

2e (see 3b). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Shale 25 feet (7.6 m.) above the basal quartzite, Seeley Street, St. John, St. John County, New Brunswick (S. W. Loper, 1899).

Protorthis billingsi.

2f (3 feet below 2g; see 308e). (For stratigraphic position and association, see p. 133.) Middle Cambrian: Sandstones of Division 1b1 of Matthew's [1895a, p. 108] *Protolenus* zone, Hanford Brook, St. John County, New Brunswick (C. D. Walcott and S. W. Loper, 1899).

*Lingulella martinensis.
Acrothele prima.
*Acrotreta inflata.
Acrotreta sagittalis transversa.

2g (3 feet above 2f and underlying 2h; see 308e). (For stratigraphic position and association, see p. 133.) Middle Cambrian: Sandstones of Division 1b1 of Matthew's [1895a, p. 108] *Protolenus* zone, Hanford Brook, St. John County, New Brunswick (C. D. Walcott and S. W. Loper, 1899).

Lingulella martinensis.
*Acrotreta inflata.
Acrotreta sagittalis.
Acrotreta sagittalis transversa.

Matthew cites the following additional species from Division 1b1:

Acrothele matthewi? (Hartt).
*Acrothele matthewi prima Matthew=Acrothele prima.
*Hipponicharion eos Matthew.
Beyrichona tinea planata (Matthew).

2h (overlying 2g; see 301). (For stratigraphic position and association, see p. 133.) Middle Cambrian: Sandstones of Division 1b2 of Matthew's [1895a, p. 108] *Protolenus* zone, Hanford Brook, St. John County, New Brunswick (C. D. Walcott and S. W. Loper, 1899).

Lingulella martinensis.
Trematobolus pristinus.
Acrothele prima.
*Acrothele prima costata.
Acrotreta sagittalis transversa.

Matthew cites the following additional species from Division 1b2:

Beyrichona tinea Matthew.
*Beyrichona tinea planata (Matthew).
Beyrichona rotundata Matthew.
Beyrichona ovata Matthew.
Indiana secunda Matthew.

2i (underlying 2k). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Sandstones of Division 1b3 of Matthew's [1895a, p. 108] *Protolenus* zone, Hanford Brook, St. John County, New Brunswick (C. D. Walcott and S. W. Loper, 1899).

Lingulella ferruginea?.
Lingulella martinensis.
Botsfordia sp.
Trematobolus pristinus.
Acrothele prima.
Acrothele prima costata.
Acrotreta sagittalis magna.
Acrotreta sagittalis transversa.

Matthew cites the following additional species from Division 1b3:

Bradoria henepuncta (Matthew).
Bradoria minor (Matthew).
*Bradoria cambrica (Matthew).
Bradoria oculata (Matthew).
Indiana lippa (Matthew).
Indiana secunda pyriformis (Matthew).
Walcottella fusiformis (Matthew).
Beyrichona tinea Matthew.
Beyrichona tinea planata (Matthew).
*Beyrichona tinea triangularis (Matthew).
Beyrichona papilio (Matthew).
*Beyrichona rotundata Matthew.
*Hipponicharion minus Matthew.
*Hipponicharion cavatum Matthew.

2k (just above 2i). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Sandstones of Division 1b3 of Matthew's [1895a, p. 108] *Protolenus* zone, Hanford Brook, St. John County, New Brunswick (C. D. Walcott and S. W. Loper, 1899).

Trematobolus pristinus.
Acrothele prima costata.
Acrotreta sagittalis transversa.

Matthew cites the following additional species from this locality:

Indiana secunda pyriformis (Matthew).
Beyrichona tinea Matthew.

2l (underlying 2m). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Limestone at the base of the *Paradoxides* zone [Matthew, 1895a, p. 108], Hanford Brook, St. John County, New Brunswick (S. W. Loper, 1899).

Lingulella ferruginea.
Acrothele matthewi.
Acrothele matthewi multicostata.
Acrotreta sagittalis magna.
Protorthis billingsi.
*Eoorthis hastingsensis.

Matthew cites the following additional species from the base of the *Paradoxides* zone at this locality:

Beyrichona tinea Matthew.

2m (overlying 2l). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Shales near the base of the *Paradoxides* zone [Matthew, 1895a, p. 108], Hanford Brook, St. John County, New Brunswick (S. W. Loper, 1899).

Lingulella ferruginea.
Acrothele matthewi.
Protorthis billingsi.
Eoorthis hastingsensis.

2n. Lower Cambrian: Limestone bowlders in conglomerate along the shore of the St. Lawrence, near Trois Pistoles, Temiscouata County, Quebec, Canada (C. D. Walcott, 1899).

*Micromitra (Paterina) bella.
*Micromitra (Paterina) logani.

2o (see 2p and 2r). Lower Cambrian: Limestone bowlders in conglomerate on shore at east entrance to harbor at Bic, Rimouski County, Quebec, Canada (C. D. Walcott, 1899).

Micromitra (Paterina) bella.
Micromitra (Paterina) labradorica.
Bicia gemma.
Kutorgina cingulata.
Obolella crassa.
Botsfordia cælata.
Yorkia wanneri?.
Nisusia festinata.
Discinella sp.

2p (see 2o and 2r). Lower Cambrian: Limestone on south side of the road a little west of Bic and half a mile (0.8 km.) west of the road leading to the wharf, Rimouski County, Quebec, Canada (C. D. Walcott, 1899).

Bicia gemma.
Botsfordia cælata.

2r (see 2o and 2p). Lower Cambrian: Limestone bowlders in a conglomerate in a cut on the Intercolonial Railway, 2 miles (3.2 km.) west of Bic railway station, Rimouski County, Quebec, Canada (C. D. Walcott, 1899).

*Micromitra nisus.
Micromitra (Paterina) labradorica?.
Botsfordia cælata.
Callavia bicensis Walcott.

2s (see 2t). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Limestone in upper part of *Paradoxides* zone, at Hastings Cove [see Matthew, 1898b, p. 38], on Kennebecasis Bay, 0.5 mile (0.8 km.) northeast of Torryburn, on the Intercolonial Railway, northeast of St. John, St. John County, New Brunswick (C. D. Walcott, 1899).

Lingulella ferruginea.
Acrothele matthewi.
Acrothele matthewi multicostata.
*Acrotreta gracia.
Acrotreta misera.
Acrotreta sagittalis.
*Acrotreta sagittalis magna.
Billingsella coloradoensis.
Billingsella sp.
Eoorthis hastingsensis.

Matthew cites the following additional species from this locality:
Indiana primæva (Matthew).
Indiana dermatoides (Walcott).

2t (shale in which limestone of 2s is interbedded). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Shales in upper part of *Paradoxides* zone, at Hastings Cove [see Matthew, 1898b, p. 38], on Kennebecasis Bay, 0.5 mile (0.8 km.) northeast of Torryburn, on the Intercolonial Railway, northeast of St. John, St. John County, New Brunswick (C. D. Walcott, 1899).

*Acrothele matthewi multicostata.
Acrotreta misera.

2u (below 2x; see 308g). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Lowes beds exposed on the south side of Long Island, Kennebecasis Bay [see Matthew, 1898a, pp. 124 and 127], St. John County, New Brunswick (C. D. Walcott, 1899).

Trematobolus kempanum.
*Protorthis helena.
Protorthis (Loperia) dugaldensis.

2x (=locality given by Matthew [1892, p. 59]; a higher horizon than 2u). (For stratigraphic position and association, see p. 131.) Upper Cambrian: Thin-bedded sandstones of Division 2 of Matthew [1892, p. 59], on the south shore of Long Island, Kennebecasis Bay [see Matthew, 1898a, pp. 124 and 127], St. John County New Brunswick (C. D. Walcott, 1899).

*Lingulella minor.
Lingulella minor?.
Lingulella (Lingulepis) starri.

2y. (For stratigraphic position and association, see p. 133.) Middle Cambrian: Sandstone about 25 feet (7.6 m.) above the Lower Cambrian, on the southeast side of Catons Island, in Long Reach, St. John River, Kings County, New Brunswick (C. D. Walcott, 1899).

Botsfordia pulchra.

2z. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Nolichucky(?) shale [Campbell, 1899, p. 3], near Shipley Ferry, 0.75 mile (1.2 km.) northwest of Bethany Chapel, northeastern corner of the Roan Mountain quadrangle (U. S. G. S.), Sullivan County, Tenn. (M. R. Campbell, 1894).

Dicellomus appalachia.

2z′. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales in the Honaker limestone [Campbell, 1899, p. 3], at Wallace switch, about 5 miles (8 km.) northeast of Bristol, Bristol quadrangle (U. S. G. S.), Sullivan County, Tenn. (T. C. Mendenhall and M. R. Campbell, 1894).

Dicellomus appalachia.

3 (highest horizon on Manuels Brook). (For stratigraphic position and association, see p. 140.) Upper Cambrian: Shaly limestones 300 feet (91.4 m.) above the *Paradoxides* zone, Manuels Brook, Conception Bay, Newfoundland (C. D. Walcott, 1888).

Lingulella ferruginea.
Acrothele matthewi.
Acrotreta sagittalis transversa.
Orusia lenticularis.

3a. Lower Cambrian: 450 feet (137.1 m.) below the quartzite in the St. John formation and over 500 feet (152.4 m.) below the *Protolenus* fauna of Matthew [see Walcott, 1900, pp. 320–322], Hanford Brook, St. John County, New Brunswick (C. D. Walcott, 1899).

Micromitra (Paterina) labradorica.

3b (see 2e). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Shale at the base of the *Paradoxides* zone, head of Seeley Street, St. John, St. John County, New Brunswick (S. W. Loper, 1899).

Acrothele matthewi.
Protorthis billingsi.
Protorthis quacoensis.

3c. (For stratigraphic position and association, see p. 158.) Middle Cambrian: Shales about 75 feet (22.9 m.) above the quartzitic sandstones of the Cambrian, at Ophir, Oquirrh Range, Tooele County, Utah (H. E. Dickhaut, 1900).

Obolus (Westonia) ella.

3d. (For stratigraphic position and association, see p. 157.) Middle Cambrian: Concretionary limestone about 100 feet (30.5 m.) above the quartzitic sandstones of the Cambrian, at Ophir, Oquirrh Range, Tooele County, Utah (H. E. Dickhaut, 1900).

Micromitra sp.
Micromitra (Paterina) labradorica utahensis.
Obolus (Westonia) ella.
Olenoides?.

3e. (For stratigraphic position and association, see p. 156.) Middle Cambrian: Thin-bedded limestone less than 400 feet (121.9 m.) above the quartzitic sandstones of the Cambrian, at Ophir, Oquirrh Range, Tooele County, Utah (H. E. Dickhaut, 1900).

Micromitra sp.
*Micromitra (Iphidella) pannula ophirensis.
Obolus matinalis.
Obolus tetonensis.
Lingulella arguta.
*Acrothele subsidua lævis.
*Acrotreta ophirensis.
*Acrotreta ophirensis rugosa.
Olenoides?.

3g (see 360h). Middle Cambrian: Shales on river bank 250 feet (76.2 m.) above west end of Denver and Rio Grande Railway tunnel, Glenwood Springs, Garfield County, Colo.

Obolus (Westonia) ella.
Lingulella sp.

3h. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shale and shaly limestone, on McNeil Brook, 1.5 miles (2.4 km.) east of Marion Bridge, Cape Breton, Nova Scotia (S. W. Loper, 1900).

*Obolus acadicus.
Obolus (Bröggeria) salteri.
Lingulella concinna.
Lingulella ferruginea.
Schizambon priscus.

3i. (For stratigraphic position and association, see p. 132.) Middle Cambrian: Compact, fine-grained, thin-bedded gray sandstone of the *Paradoxides* zone, on McLean Brook, 1 mile (1.6 km.) east of McCodrum Brook and 1.5 miles (2.4 km.) west of Marion Bridge, Cape Breton, Nova Scotia (S. W. Loper, 1900). Matthew [1903, p. 195] says the horizon is his Division C2b.

*Lingulella cania.
Lingulella concinna.
Lingulella ferruginea.
Lingulella rotunda.
*Lingulella (Lingulepis) exigua.
Acrothyra proavia.

3j (same locality as 5j, but 25 feet above; see 4v and 4q). Middle Cambrian: Above the quartzitic sandstones, in a shale corresponding in position to the upper part of shale No. 6 of the Dearborn River section [Walcott, 1908f, p. 202], about 6 miles (9.6 km.) west-northwest of Scapegoat Mountain, on the Continental Divide between Bar Creek and the headwaters of the south fork of the North Fork of Sun River, Coopers Lake quadrangle (U. S. G. S.) Powell County, Mont. (C. D. Walcott, 1905).

Obolus mcconnelli.
Bathyuriscus productus (Hall and Whitfield).

3n. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Thin-bedded sandstone on Salmon River, Gillis Hill, 13 miles (20.9 km.) south of Marion Bridge, eastern Cape Breton, Nova Scotia (S. W. Loper, 1900).

Lingulella minor.
Lingulella (Lingulepis) exigua.
*Acrotreta convexa.

3o (see 372c). (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shales in the first ravine south of the post office at Barachois, east of Little Bras d'Or Lake, eastern Cape Breton, Nova Scotia (S. W. Loper, 1900).

Lingulella concinna.

3p. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shales in ravine 0.5 mile (0.8 km.) north of McMullins, on the crossroad to Boisdale station, eastern Cape Breton, Nova Scotia (S. W. Loper, 1900).

Lingulella concinna.

3q. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shale in Barachois Glen, 4 miles (6.4 km.) south of Little Bras d'Or Lake, eastern Cape Breton, Nova Scotia (S. W. Loper, 1900).

Obolus (Bröggeria) salteri.
Lingulella concinna.
Schizambon priscus.
Acrotreta bisecta.

3s (same horizon as 1z, 4, and 15b; =3t and 8g). (For stratigraphic position and association, see p. 156.) Middle Cambrian: About 1,700 feet (518.2 m.) above the Lower Cambrian and 2,700 feet (823 m.) below the Upper Cambrian, in the shaly limestones and calcareous shales of the Wheeler formation [Walcott, 1908f, p. 181], in the eastern part of Wheeler Amphitheater, east of Antelope Springs, House Range [Walcott, 1908f, Pls. XIII and XV], Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1903 and 1905).

Obolus mcconnelli pelias.
Acrothele subsidua.
Acrotreta attenuata.
Agnostus bidens (Meek).
Ptychoparia kingi (Meek).
Ptychoparia sp.
Asaphiscus wheeleri (Meek).

3t (=3s, which see). (For stratigraphic position and association, see p. 156.)

3v. (For stratigraphic position and association, see p. 158.) Middle Cambrian: About 200 feet (61 m.) above the Lower Cambrian in the "Spence shale" [Walcott, 1908f, p. 183] (described in this monograph, p. 158, as 1h of the Howell formation), in Dome Canyon, about 5 miles (8 km.) west of Antelope Springs, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah.

(See p. 158 for list of species.)

3w (same horizon as 30g and 11q). (For stratigraphic position and association, see p. 156.) Middle Cambrian: About 2,350 feet (716.3 m.) above the Lower Cambrian and 2,050 feet (624.8 m.) below the Upper Cambrian, in the central portion of the thin-bedded limestones forming 1c of the Marjum limestone [Walcott, 1908f, p. 180], in the cliff about 2 miles (3.2 km.) southeast of Marjum Pass, House Range [see Walcott, 1908f, Pls. XIII and XV], Millard County, Utah (C. D. Walcott, 1903).

Lingulella arguta.
Acrotreta bellatula.
Ptychoparia.
Neolenus.

3x (=11x). (For stratigraphic position and association, see p. 156.) Middle Cambrian: About 2,200 feet (670.6 m.) above the Lower Cambrian and 2,200 feet (670.6 m.) below the Upper Cambrian, in the limestones forming 1d of the Marjum limestone [Walcott, 1908f, p. 180], 2.5 miles (4 km.) east of Antelope Springs, in ridge east of Wheeler Amphitheater, House Range [Walcott, 1908f, Pls. XIII and XV], Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1905).

Micromitra sculptilis.
Micromitra (Iphidella) pannula ophirensis
Obolus mcconnelli pelias.
Obolus rotundatus.
Lingulella arguta.
Acrothele subsidua.
Acrothele subsidua lævis.
Acrotreta attenuata.
Acrotreta ophirensis.
Eoorthis remnicha?.
*Eoorthis thyone.
*Syntrophia? unxia.
Agnostus 3 sp.
Ptychoparia.
Neolenus inflatus Walcott.
Neolenus intermedius Walcott.
Neolenus superbus Walcott.
Ogygopsis?.

3y. (For stratigraphic position and association, see p. 156.) Middle Cambrian: About 2,150 feet (655.3 m.) above the Lower Cambrian and 2,250 (685.8 m.) below the Upper Cambrian, in the shaly limestones forming 1d of the Marjum limestone [Walcott, 1908f, p. 180], 2.5 miles (4 km.) east of Antelope Springs, in ridge east of Wheeler Amphitheater, House Range [Walcott, 1908f, Pls. XIII and XV], Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1905).

Obolus mcconnelli pelias.
Acrotreta ophirensis.
Agnostus.
Ptychoparia.
Ogygopsis?.

4 (same horizon as 3s). (For stratigraphic position and association, see p. 156.) Middle Cambrian: Drift pieces believed to have come from the Wheeler formation [Walcott, 1908f, p. 181], collected near Antelope Springs, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (J. F. Gibbs, 1889).

*Acrothele subsidua.
Agnostus interstrictus White.
Ptychoparia kingi (Meek).
Asaphiscus wheeleri (Meek).

4e (see 4m and 4n). Middle Cambrian: Limestones about 950 feet (289.6 m.) above the unconformable base of the Cambrian, in the divide at head of Jackson Creek (locally known as Sheep Creek), a creek flowing into Jackson Lake about 0.5 mile (0.8 km.) south of its northwestern corner, Teton Mountains, Grand Teton quadrangle (U. S. G. S.), Uinta County, Wyo. (C. D. Walcott, 1898).

*Obolus tetonensis.
Lingulella (Lingulepis) acuminata meeki.
*Acrotreta microscopica tetonensis.
Billingsella coloradoensis.

(Possibly the last named is from a bed different from that containing the other species.)

4g (50 feet below 4h; see 4h, 4k, and 4p). Middle Cambrian: About 325 feet (99.1 m.) above the base of the Cambrian, in the Flathead shales of Peale [1893, p. 21], 1 mile (1.6 km.) north of the junction of East Gallatin and West Gallatin (Gallatin) rivers, 4 miles (6.4 km.) east-northeast of Logan, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (C. D. Walcott).

Obolus (Westonia) ella.

4h (50 feet above 4g; see 4g, 4k, and 4p). Middle Cambrian: About 375 feet (114.3 m.) above the base of the Cambrian, in limestone interbedded in the Flathead shales of Peale [1893, p. 21], 1 mile (1.6 km.) north of the junction of East Gallatin and West Gallatin (Gallatin) rivers, 4 miles (6.4 km.) east-northeast of Logan, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (C. D. Walcott).

Micromitra pealei.
Obolus tetonensis.
Lingulella (Lingulepis) acuminata meeki.
Acrotreta pyxidicula.

4j. Middle Cambrian: Limestone at the head of Deep Creek, Canyon quadrangle (U. S. G. S.), Yellowstone National Park, Wyo.

Billingsella plicatella.
Eoorthis sp.
*Huenella abnormis.

The first and third of these fossils may not have been collected from the same bed.

4k (4i is limestone interbedded in these shales; see 4g, 4h, and 4p). Middle Cambrian: About 725 feet (221 m.) above the base of the Cambrian, in the shales of the Gallatin formation of Peale [1893, Pl. IV], on the north side of West Gallatin (Gallatin) River, northeast of Logan, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (C. D. Walcott, 1898).

Obolus (Westonia) ella.

4l. (For stratigraphic position and association, see pp. 140 and 158.) Lower Cambrian: Limestone in the equivalent of the Pioche formation at Pioche and in the House Range [Walcott, 1908a, p. 11], on a ridge 2.5 miles (4 km.) northwest of the town of Cherry Creek, White Pine County, Nev. (O. H. Hershey).

Micromitra (Iphidella) pannula.
Acrotreta claytoni.
Acrotreta primæva.

4m (about 175 feet below 4n). Middle Cambrian: Sandstones about 150 feet (45.7 m.) above the unconformable base of the Cambrian, in the divide at the head of Jackson Creek (locally known as Sheep Creek), a creek flowing into Jackson Lake about 0.5 mile (0.8 km.) south of its northwestern corner, Teton Mountains, Grand Teton quadrangle (U. S. G. S.), Uinta County, Wyo. (C. D. Walcott, 1898).

Obolus tetonensis.

4n (about 175 feet above 4m). Middle Cambrian: Limestone about 325 feet (99.1 m.) above the unconformable base of the Cambrian, in divide at the head of Jackson Creek (locally known as Sheep Creek), a creek flowing into Jackson Lake about 0.5 mile (0.8 km.) south of its northwestern corner, Teton Mountains, Grand Teton quadrangle (U. S. G. S.), Uinta County, Wyo. (C. D. Walcott and F. B. Weeks, 1898).

Micromitra pealei.
Obolus (Westonia) ella.
Lingulella helena.
Acrotreta attenuata.

M. pealei also occurs in locality 4n′, which is probably a slightly different bed at the locality given for 4n.

4o (about 50 feet above 4n). Middle Cambrian: Shale about 375 feet (115 m.) above the unconformable base of the Cambrian, in divide at the head of Jackson Creek (locally known as Sheep Creek), a creek flowing into Jackson Lake about 0.5 mile (0.8 km.) south of its northwestern corner, Teton Mountains, Grand Teton quadrangle (U. S. G. S.), Uinta County, Wyo. (C. D. Walcott, 1898).

Acrotreta definita.

4p (see 4g, 4h, and 4k). Middle Cambrian: About 225 feet (68.6 m.) above the base of the Cambrian, in limestones interbedded in the Flathead shales of Peale [1893, p. 21], on the north side of West Gallatin (Gallatin) River, 2 miles (3.2 km.) northeast of Logan, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (C. D. Walcott, 1898).

Micromitra pealei.

4q (115 feet above 4v; see 3j and 4v). Middle Cambrian: About 315 feet (96 m.) above the unconformable base of the Cambrian and 190 feet (57.9 m.) above the top of the quartzitic sandstones, in a shale which corresponds in position to the upper part of shale No. 6 of the Dearborn River section [see Walcott, 1908f, p. 202], on the ridge between Gordon and Youngs creeks, about halfway between Gordon Mountain and Cardinal Peak, Ovando quadrangle (U. S. G. S.), Powell County, Mont. (C. D. Walcott, 1905).

*Micromitra (Iphidella) nyssa.
Micromitra (Iphidella) pannula.
*Acrothele colleni.
Wimanella simplex.
Ptychoparia 3 sp.
Bathyuriscus productus (Hall and Whitfield).
Zacanthoides.

4q′ (just below 4q; see 3j, 4q, and 4v). Middle Cambrian: Limestone about 310 feet (94.5 m.) above the unconformable base of the Cambrian and 185 feet (56.4 m.) above the top of the quartzitic sandstones, in a shale which corresponds in position to the upper part of shale No. 6 of the Dearborn River section [see Walcott, 1908f, p. 202], on the ridge between Gordon and Youngs creeks, about halfway between Gordon Mountain and Cardinal Peak, Ovando quadrangle (U. S. G. S.), Powell County, Mont. (C. D. Walcott, 1905).

Micromitra (Iphidella) pannula.
Obolus (Westonia) ella.

4r. Upper Cambrian: Just above the Middle Cambrian, in the limestones of the Gallatin formation of Peale [1893, Pl. IV], on a ridge 8 miles (12.8 km.) east of Yellowstone River and 3 miles (4.8 km.) north-northeast of Mount Delano, Livingston quadrangle (U. S. G. S.), Park County, Mont. (C. D. Walcott, 1898).

Eoorthis remnicha.

4u. Middle Cambrian: Shales in the Gallatin formation of Peale [1893, Pl. IV], northwest side of canyon, 0.5 mile (0.8 km.) south of Helena, Jefferson County, Mont. (L. S. Griswold and C. D. Walcott, 1898).

Obolus (Westonia) ella.
Lingulella helena.

4v (115 feet below 4q; same horizon as 5j; see 3j and 4q). Lower Cambrian: About 200 feet (61 m.) above the unconformable base of the Cambrian and 75 feet (22.9 m.) above the top of the quartzitic sandstones, in a shale which corresponds in stratigraphic position to shale No. 6 of the Dearborn River section [see Walcott, 1908f, p. 202], Gordon Creek, 6 miles (9.6 km.) from South Fork of Flathead River, Ovando quadrangle (U. S. G. S.), Powell County, Mont. (C. D. Walcott, 1905).

Micromitra (Iphidella) pannula.
Obolus (Westonia) ella.
Acrothele colleni.
*Acrothele panderi.
*Wimanella simplex
Ptychoparia sp.
Olenopsis? sp.
Albertella helena Walcott.
Bathyuriscus productus (Hall and Whitfield)?.
Bathyuriscus? sp.

4w (same horizon as 4q). Lower Cambrian: About 315 feet (96 m.) above the unconformable base of the Cambrian and 190 feet (57.9 m.) above the top of the quartzitic sandstones, in a shale which corresponds in position to shale No. 6 of the Dearborn River section [see Walcott, 1908f, p. 202], on Youngs Creek, about 5 miles (8 km.) from its junction with Danaher Creek, Ovando quadrangle (U. S. G. S.), Powell County, Mont. (C. D. Walcott, 1905).

Wimanella simplex.
Ptychoparia sp.
Zacanthoides sp.

4x (a little higher than 5f; see 4g, 4h, 4k, and 5f). Middle Cambrian: Limestone interbedded in the Wolsey shale [Weed, 1900, p. 285], at the base of a butte in Belt Park, about 6 miles (9.6 km.) northwest of Neihart, Little Belt Mountains quadrangle (U. S. G. S.), Cascade County, Mont. (C. D. Walcott, 1898).

Micromitra pealei.
Obolus tetonensis.
Scenella.

4y (=54t, which see). (For stratigraphic position and association, see p. 149.) (C. D. Walcott, 1898.)

Obolus (Westonia) ella.
Billingsella coloradoensis.

5. Middle Cambrian: Siliceous shale on Hayward Creek, Braintree, Dedham quadrangle (U. S. G. S.), Norfolk County, Mass. (W. P. Rust, 1891).

Acrothele gamagei.
Hyolithes shaleri Walcott.
Agraulos quadrangularis (Whitfield).
Paradoxides harlani Green.

Grabau [1900] cites the following additional species from this locality:

Fucoids or trails?.
Parmophorella acadica (Hartt).
Hyolithes ? haywardensis Grabau.
Ptychoparia rogersi Walcott.

5a (=54t, which see). (For stratigraphic position and association, see p. 149.) (C. D. Walcott, 1898.)

Obolus wortheni.
Lingulella desiderata.
Billingsella coloradoensis.

5b (=54s, which see). (For stratigraphic position and association, see p. 152.) (C. D. Walcott, 1893.) For the species occurring at this locality, see Locality 54s.

5e (=54t, which see). (For stratigraphic position and association, see p. 149.) (C. D. Walcott and L. D. Burling, 1906.)

Obolus wortheni.
*Acrotreta idahoensis.
Billingsella coloradoensis.

5f (a little lower than 4x). Middle Cambrian: Limestone interbedded in the Wolsey shale [Weed, 1900, p. 285], in Meagher County, on the road to Wolsey, about 4 miles (6.4 km.) south of the divide at the head of Sawmill Creek and 11 miles (17.7 km.) south of Neihart, Little Belt Mountains quadrangle (U. S. G. S.), Cascade County, Mont. (C. D. Walcott, 1898).

Micromitra pealei.
Obolus (Westonia) ella.
Lingulella desiderata.
Scenella.
Dorypyge? quadriceps (Hall and Whitfield).

5h (=55d, which see). (For stratigraphic position and association, see p. 150.) (C. D. Walcott, 1898.)
Obolus (Westonia) ella.

5j (same horizon as 4v; same locality as 3j but 25 feet below). Lower Cambrian: Above the quartzitic sandstones, in a shale which corresponds in position to shale No. 6 of the Dearborn River section [see Walcott, 1908f, p. 202], about 6 miles (9.6 km.) west-northwest of Scapegoat Mountain, on the Continental Divide between Bar Creek and the headwaters of the south fork of North Fork of Sun River, Coopers Lake quadrangle (U. S. G. S.), Powell County, Mont. (C. D. Walcott, 1905).
Acrothele panderi.
Albertella helena Walcott.

5k. Middle Cambrian: Limestone in Meagher County, on the road to Wolsey, about 1 mile (1.6 km.) south of the divide at the head of Sawmill Creek and 8 miles (12.8 km.) south of Neihart, Little Belt Mountains quadrangle (U. S. G. S.), Cascade County, Mont. (C. D. Walcott, W. H. Weed, and F. B. Weeks, 1895).

Micromitra sp.
Dicellomus politus.
*Schuchertina cambria.
Billingsella coloradoensis.

5l (50 feet below 5n at same locality; same horizon as 5p and 4l). (For stratigraphic position and association, see p. 141.) Lower Cambrian: Limestone on Smith Point, in Smith Sound, Trinity Bay, Newfoundland (C. D. Walcott, 1899).
Micromitra (Paterina) labradorica.
Olenellus?.

5n (50 feet above 5l at same locality; 275 feet below 5o). (For stratigraphic position and association, see p. 141.) Lower Cambrian: Shale on Smith Point, in Smith Sound, Trinity Bay, Newfoundland (C. D. Walcott, 1899).
Obolella atlantica.
Callavia bröggeri (Walcott).

5o (about 275 feet above 5n; see 5l and 5n). (For stratigraphic position and association, see p. 141.) Lower Cambrian: Just below the Middle Cambrian, in shales on Smith Point, in Smith Sound, Trinity Bay, Newfoundland (S. W. Loper and C. D. Walcott, 1899).
Obolella atlantica.
Olenellus?.

5p (same horizon as 5l and 4l). (For stratigraphic position and association, see p. 141.) Lower Cambrian: Limestone 300 feet (91.4 m.) southeast of the railway station, Manuels, Conception Bay, Newfoundland (C. D. Walcott, 1899).
Obolella atlantica.
Callavia bröggeri (Walcott).

5r. (For stratigraphic position and association, see p. 141.) Lower Cambrian: Limestone near the railroad track, 1.5 miles (2.4 km.) west of the railway station at Manuels, Conception Bay, Newfoundland (C. D. Walcott, 1899).
Micromitra (Paterina) labradorica.
Callavia bröggeri (Walcott).

5t. (For stratigraphic position and association, see p. 141.) Lower Cambrian: Shale and limestone nodules about 20 feet (6 m.) above the base of the Cambrian, on Redrock Point, near Chapple Cove, Hollywood Point, Conception Bay, Newfoundland (J. P. Howley and C. D. Walcott, 1899).
Micromitra (Paterina) labradorica.
Obolella atlantica.
Callavia bröggeri (Walcott).

6g. (For stratigraphic position and association, see p. 141.) Middle Cambrian: Limestone near the base of the Middle Cambrian, the lowest horizon carrying *Paradoxides*, northwest side of Chapple Arm Harbor, about 1 mile (1.6 km.) from its head, Trinity Bay, Newfoundland (J. P. Howley and C. D. Walcott, 1899).

Micromitra (Iphidella) ornatella.
Micromitra (Iphidella) pannula maladensis.
Lingulella ferruginea.
Acrothele matthewi.
Acrotreta misera.
Acrotreta sagittalis.

6h. (For stratigraphic position and association, see p. 140.) Middle Cambrian: Limestone in the southwest cove of Chapple Arm, Trinity Bay, Newfoundland (C. D. Walcott, 1899).
Acrotreta misera.

6i (280 feet below 6s). (For stratigraphic position and association, see p. 140.) Middle Cambrian: Limestone about 300 feet (91.4 m.) below the base of the Upper Cambrian, on shore north of Fosters Point, Random Island, Random Sound, Newfoundland (C. D. Walcott, 1899).

Acrotreta sagittalis.
Agnostus.
Microdiscus.

6l (=1a, except that the fossils were collected on the east side of the brook). (For stratigraphic position and association, see p. 140.) (C. D. Walcott, 1899.)

Lingulella ferruginea.
Acrothele matthewi.
Acrotreta?.
*Eoorthis papias.

6n (=1a, except that the fossils were collected on the west side of the brook). (For stratigraphic position and association, see p. 140.) (C. D. Walcott, 1899.)

Lingulella ferruginea.
Acrothele matthewi.
Acrothele prima costata.

6r. (For stratigraphic position and association, see p. 140.) Middle Cambrian: Limestone on the west side of Manuels Brook, Conception Bay, Newfoundland (C. D. Walcott, 1899).

Lingulella ferruginea.
Acrotreta misera.

6s (=6u; 280 feet above 6i). (For stratigraphic position and association, see p. 140.) Upper Cambrian: Just north of Fosters Point, Random Island, Random Sound, Newfoundland (C. D. Walcott, 1899).

Lingulella ferruginea?.

6u (same horizon as 6s). (For stratigraphic position and association, see p. 140.) Upper Cambrian: Shale on the west side of Manuels Brook, Conception Bay, Newfoundland (C. D. Walcott, 1899).

Lingulella ferruginea.

6v (375 feet above 6n). (For stratigraphic position and association, see p. 140.) Upper Cambrian: Shaly limestones 325 feet (99.1 m.) above the Middle Cambrian, Manuels Brook, Conception Bay, Newfoundland (C. D. Walcott, 1899).

Orusia lenticularis.

6w. (For stratigraphic position and association, see p. 140.) Middle Cambrian: Limestone at Seal Point Cove, near Long Point, Trinity Bay, Newfoundland (C. D. Walcott, S. W. Loper, and J. P. Howley, 1899).

Acrotreta sagittalis.

6y. (For stratigraphic position and association, see p. 140.) Upper Cambrian: Sandstone on north side of Random Island, between Birch and Sandy points, Smith Sound, Trinity Bay, Newfoundland (C. D. Walcott and S. W. Loper, 1899).

*Lingulella randomensis.

7. (For stratigraphic position and association, see p. 138.) Lower Cambrian: Shaly beds about 1,000 feet (305 m.) above the quartzitic beds, Silver Canyon, White Mountain Range, Inyo County, Cal. (C. D. Walcott, 1894).

Kutorgina perugata.
Yorkia wanneri?.

7d. (For stratigraphic position and association, see p. 147.) Upper Cambrian: Shales in second cliff, 0.125 mile (0.2 km.) west of Peak post office, 3 miles (4.8 km.) south of Clinton, Briceville quadrangle (U. S. G. S.), Anderson County, Tenn.

Obolus lamborni.
Lingulella ino.

7i. (For stratigraphic position and association, see p. 139.) Middle Cambrian: Limestone just west of the summit, on the road east of Schellbourne, Schell Creek Range, White Pine County, Nev. (J. E. Spurr, 1899).

Obolus rotundatus.
Lingulella manticula.
Lingulella punctata.
Acrotreta idahoensis alta.

7j. Middle Cambrian: Limestones at the north end of the Quinn Canyon Range, 1 mile (1.6 km.) northwest of the Italian Ranch foothills, Nye County, Nev. (J. E. Spurr, 1899).

Micromitra 2 sp. undt.
Obolus rotundatus.
Lingulella manticula.
°Lingulella similis.
*Acrotreta cf. idahoensis.
°Acrotreta primæva?.
°Acrotreta pyxidicula.

Fossils marked ° may not all be from the same bed or even from the same approximate stratigraphic horizon.

7k (see 31 and 333b). (For stratigraphic position and association, see p. 158.) Middle Cambrian: Shales in the dumps of the Half-moon and Chisholm mines, southwest slope of Ely Mountains, 3 miles (4.8 km.) northwest of Pioche, Lincoln County, Nev. (J. E. Spurr, 1899).

Obolus (Westonia) ella.

7n. Upper? Cambrian: Limestone at Hornet Spring in the Spring Mountain Range, on the road from Indian Spring to Pahrump Valley, Lincoln County, Nev. (J. E. Spurr, 1899).

*Obolus sp. undt. b.

7r (see 7s and 7v). Middle Cambrian: Calcareous shales 4 miles (6.4 km.) south-southeast of Emigrant Peak, Silver Peak quadrangle (U. S. G. S.), Esmeralda County, Nev. (H. W. Turner, 1899).

Obolus mcconnelli decipiens.
*Acrothele turneri.

7s (see 7r and 7v). Upper Cambrian: Shales of the Emigrant formation [Turner, 1902, p. 265], 4 miles (6.4 km.) south-southeast of Emigrant Peak, Silver Peak quadrangle (U. S. G. S.), Esmeralda County, Nev. (H. W. Turner, 1899).

Obolus mcconnelli pelias.

7v (see 7r and 7s). Upper Cambrian: Shales of the Emigrant formation [Turner, 1902, p. 265], 4.25 miles (6.8 km.) south-southeast of Emigrant Peak, Silver Peak quadrangle (U. S. G. S.), Esmeralda County, Nev. (H. W. Turner, 1899).

*Obolus mcconnelli decipiens.
Acrotreta argenta.

7w. (For stratigraphic position and association, see p. 156.) Middle Cambrian: Limestone in Rock Canyon in the Wasatch Mountains, east of Provo, Utah County, Utah (G. H. Girty, 1900).

*Nisusia (Jamesella) utahensis.
Dorypyge?.

7x (=7y; 50 feet below 8a). Upper Cambrian: Limestone of the Emigrant formation [Turner, 1902, p. 265], about 2.5 miles (4 km.) southeast of Emigrant Pass, Silver Peak quadrangle (U. S. G. S.), Esmeralda County, Nev. (F. B. Weeks, 1900).

Obolus mcconnelli decipiens.
*Obolus (Fordinia) bellulus.
Lingulella desiderata.
Lingulella (Lingulepis) acuminata.
Acrotreta argenta.
Menocephalus sp.

7y (=7x, which see). (F. B. Weeks, 1900.)

Obolus (Fordinia) bellulus.
Lingulella desiderata.
Lingulella (Lingulepis) acuminata.
Acrotreta argenta.
Menocephalus.

7z. Upper Cambrian: Limestone of the Emigrant formation [Turner, 1902, p. 265], about 3 miles (4.8 km.) southeast of Emigrant Pass, Silver Peak quadrangle (U. S. G. S.), Esmeralda County, Nev. (F. B. Weeks, 1900).

Obolus (Fordinia) bellulus.
Lingulella desiderata.
Lingulella (Lingulepis) acuminata.

8a (50 feet above 7x). Upper Cambrian: Shaly limestones of the Emigrant formation [Turner, 1902, p. 265], 2 miles (3.2 km.) southeast of Emigrant Pass, Silver Peak quadrangle (U. S. G. S.), Esmeralda County, Nev. (F. B. Weeks, 1900).

Obolella?.

8b. Lower Cambrian: Limestone in Tollgate Canyon, about 15 miles (24.1 km.) east of White Pine, White Mountain Range, Inyo County, Cal. (C. D. Walcott, 1894).

Kutorgina sp.
Obolella vermilionensis.
*Wimanella inyoensis.

8b′. Upper Cambrian: Shales of the Emigrant formation [Turner, 1902, p. 265], in a ravine on the east side of the road about 1 mile (1.6 km.) southwest of Emigrant Pass, Silver Peak quadrangle (U. S. G. S.), Esmeralda County, Nev. (F. B. Weeks, 1900).

*Acrotreta argenta.

8d (see 372). (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shales at Upper Leitches Creek, eastern Cape Breton, Nova Scotia (S. W. Loper, 1900).

Lingulella concinna.

8e. (For stratigraphic position and association, see p. 139.) Upper Cambrian: Limestone in Patterson Canyon, west side of the Schell Creek Range, White Pine County, Nev. (F. B. Weeks, 1900).

Lingulella manticula.

8f. (For stratigraphic position and association, see p. 139.) Upper Cambrian: Limestone at summit of canyon 10 miles (16.1 km.) south of Egan Canyon, east side of Egan Range, White Pine County, Nev. (F. B. Weeks, 1900).

Obolus discoideus.
Lingulella manticula.
Lingulella punctata.
Eoorthis?.

8g (=3s and 3t, which see). (For stratigraphic position and association, see p. 156.) (F. B. Weeks, 1900.)

Obolus mcconnelli pelias.
Acrothele subsidua.

8i. (For stratigraphic position and association, see p. 156.) Middle Cambrian: Shales believed to be referable to the lower portion of the Marjum limestone [Walcott, 1908f, p. 180], found about 0.5 mile (0.8 km.) east of Antelope Springs, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (F. B. Weeks, 1900).

Micromitra sculptilis.
Obolus mcconnelli pelias.
Kutorgina sp.

8j. Middle Cambrian: About 575 feet (175.3 m.) above the unconformable base of the Cambrian, in a shale which corresponds in position to shale No. 4 of the Dearborn River section [see Walcott, 1908f, p. 202], on the ridge between Gordon and Youngs creeks, about halfway between Gordon Mountain and Cardinal Peak, Ovando quadrangle (U. S. G. S.), Powell County, Mont. (C. D. Walcott, 1905).

Micromitra (Paterina) superba.
Obolus mcconnelli pelias.
Bathyuriscus productus? (Hall and Whitfield).
Ptychoparia sp.
Zacanthoides sp.

8k. (For stratigraphic position and association, see p. 156.) Middle Cambrian: Shales 0.5 mile (0.8 km.) northwest of Tyler Springs, east slope of House Range, east of Antelope Springs [Walcott, 1908f, Pl. XIII], Millard County, Utah (F. B. Weeks, 1900).

Obolus mcconnelli pelias.

8m. (For stratigraphic position and association, see p. 139.) Middle Cambrian: Limestone near the south end of the high ridge 4 miles (6.4 km.) northeast of Osceola, White Pine County, Nev. (F. B. Weeks, 1900).

Obolus mcconnelli.
Obolus mcconnelli decipiens.

8n. (For stratigraphic position and association, see p. 139.) Upper Cambrian: Limestone about 500 feet (152 m.) up in the Cambrian limestones east of Swallow ranch, west side of the Snake Range, 20 miles (32.2 km.) south of Osceola, White Pine County, Nev. (F. B. Weeks, 1900).

Lingulella desiderata.

8o. (For stratigraphic position and association, see p. 139.) Upper Cambrian: Limestone on the slope of the ridge where the range swings around to the northwest, 2 miles (3.2 km.) north of Aurum, Schell Creek Range, White Pine County, Nev. (F. B. Weeks, 1900).

* Micromitra sculptilis endlichi.
Micromitra sp.
Obolus rotundatus.
Lingulella punctata.
Acrotreta microscopica.
Eoorthis sp.

8p. (For stratigraphic position and association, see p. 139.) Upper Cambrian: Limestone halfway up the canyon east of McGill's ranch, on the west side of the Schell Creek Range, 14 miles (22.5 km.) northeast of Ely, White Pine County, Nev. (F. B. Weeks, 1900).

Obolus rotundatus?.

8q. Lower Cambrian: Shales near the contact between the Cambrian and the Triassic, 2 miles (3.2 km.) northwest of York, York County, Pa. (A. Wanner, 1900).

Obolus sp.
Olenellus thompsoni rudis Walcott.

8r. Upper Cambrian: Shales of the Emigrant formation [Turner, 1902, p. 265], about 8 miles (12.8 km.) southeast of Emigrant Peak, Silver Peak quadrangle (U. S. G. S.), Esmeralda County, Nev. (H. W. Turner).

Obolus mcconnelli decipiens.

8v. (For stratigraphic position and association, see p. 146.) Lower Cambrian: Shales in upper portion of *Holmia kjerulfi* zone, Ringsaker, near Lake Mjösen, Province of Hedemarken, Norway (Schmalensee, 1900).

Obolella mobergi.
* Acrothele bellapunctata.

8w (see 310 l, 320f, and 321y). (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones of *Paradoxides forchhammeri* zone, at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad, Sweden (Schmalensee, 1900).

Micromitra pusilla.
Micromitra (Iphidella) ornatella.
*Obolus schmalenseei.
Lingulella ferruginea.
Lingulella sp.
Acrothele coriacea.
Acrotreta sagittalis.
*Acrotreta schmalenseei.
Acrotreta socialis.
Dolichometopus svecicus Angelin.
Elyx laticeps Angelin.
Solenopleura holometopa Angelin.

8x. (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: *Ceratopyge* limestone at the cement works at Slemmestad, in Röken, about 3 miles (4.8 km.) southwest of Christiania, Norway (Schmalensee, 1900).

Obolus (Bröggeria) salteri.
Lingulella lepis.
Lingulella sp.
Acrothele coriacea.
*Acrotreta seebachi.
Acrotreta socialis.
Eoorthis daunus.
Eoorthis wimani.
Ceratopyge forficula Sars.
Triarthrus angelini Linnarsson.

8y. (For stratigraphic position and association, see p. 146.) Lower Cambrian: With *Torellella lævigata* in the "Sparagmite" sandstone, at Skårösen, northwest Dalarne, Province of Kopparberg, Sweden (Schmalensee, 1900).

Lingulella nathorsti.
Torellella lævigata Linnarsson.

8z. (For stratigraphic position and association, see p. 146.) Middle Cambrian: Limestones of *Paradoxides ælandicus* zone, Borgholm, Oeland Island, Sweden (Schmalensee, 1900).

Acrothele (Redlichella) granulata.
Acrotreta socialis.
Acrotreta sp.
Liostracus aculeatus Angelin.
Ellipsocephalus polytomus Linnarsson.

9 (same horizon as 9a). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone on southeastern slope of ridge 1 mile (1.6 km.) north of the northwest corner of Harlan Knob, about 4 miles (6.4 km.) northeast of Rogersville [see Keith, 1905, areal geology sheet], Hawkins County, Tenn. (C. D. Walcott, 1891).

Lingulella desiderata.

9a (same horizon as 9). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone on the south shore of Holston River, at Melinda Ferry, 5 miles (8 km.) southwest of Rogersville [see Keith, 1896a, areal geology sheet], Hawkins County, Tenn. (C. D. Walcott, 1891).

Lingulella desiderata.
Lingulella similis.

9d. (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone at Jaggowal, about 20 miles (32.2 km.) east-southeast of Reval, Government of Esthonia, Russia (Schmalensee, 1900).

Obolus apollinis.
Obolus triangularis.
Keyserlingia buchi.

9e. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Sandstone in the *Obolus* conglomerate at Boda, north of Rattvik, Dalarne, Sweden (Schmalensee, 1900).

Obolus apollinis.

9f. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Limestones of the *Olenus* zone at Nœrsnæs, west of Christiania, Norway (Schmalensee, 1900).

Lingulella lepis.
Orusia lenticularis.
Peltura scarabæoides Wahlenberg.

9h (limestone above the Wolsey shale). Middle Cambrian: Limestone on Beaver Creek, 5 miles (8 km.) north of York, about 8 miles (12.8 km.) north of Canon Ferry, Big Belt Mountains, Fort Logan quadrangle (U. S. G. S.), Meagher County, Mont. (C. D. Walcott, 1900).

Micromitra pealei.
Obolella?.
Acrotreta attenuata.
Billingsella plicatella.

9k. Middle Cambrian: Limestone forming 1c of the Dearborn River section [Walcott, 1908f, p. 201], on North Fork of Dearborn River, in the eastern part of the Lewis and Clark National Forest, Lewis and Clark County, Mont. (C. D. Walcott, 1900).

*Dearbornia clarki.

9m. Middle Cambrian: Shale 4 miles (6.4 km.) above Walker's ranch, on North Fork of Dearborn River, in the eastern part of the Lewis and Clark National Forest, Lewis and Clark County Mont. (C. D. Walcott, 1900).

Obolus (Westonia) ella.

9n (=326e). Lower Cambrian: Dark purplish siliceous shales on Pearl Street, North Weymouth, Norfolk County, Mass. (H. T. Burr, 1900).

Obolella atlantica.
Callavia burri Walcott.
Callavia crosbyi Walcott.

9o. Middle Cambrian: Siliceous limestone about 15 feet (4.6 m.) above the Coronado quartzite [Lindgren, 1905, p. 3], 0.5 mile (0.8 km.) southwest of Milk ranch, on the first spur north of the one which the main road follows, Clifton quadrangle (U. S. G. S.), Graham County, Ariz. (J. M. Boutwell, 1901).

Lingulella lineolata.
Lingulella perattenuata.

9p (about 115 feet above 9r; 55 feet above 12s; almost same horizon as 9x; 10 feet below 9t). (For stratigraphic position and association, see p. 142.) Upper Cambrian: About 160 feet (48.8 m.) above the porphyry contact in the limestone of the Reagan sandstone, in SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W., about 15 miles (24.2 km.) northwest of Fort Sill, Comanche County, Okla. (E. O. Ulrich, 1901).

Obolus tetonensis ninus.
*Lingulella ora.
Linnarssonella girtyi.
Ptychoparia sp.
Chariocephalus sp.
Illænurus sp.

9q (50 feet below 12d). (For stratigraphic position and association, see p. 142.) Upper Cambrian: About 10 feet (3 m.) above the porphyry contact and 90 feet (27.4 m.) below the Arbuckle limestone, in limestone of the Reagan sandstone, in middle of west half of sec. 2, T. 4 N., R. 13 W., about 15 miles (24.2 km.) northwest of Fort Sill, Comanche County, Okla. (E. O. Ulrich, 1901).

Obolus tetonensis ninus.
Lingulella ora.
Lingulella (Lingulepis) acuminata.
Linnarssonella girtyi.
Linnarssonella girtyi?.
Eoorthis wichitaensis.
Agnostus sp.
Agraulos sp.
Ptychoparia sp.
Pterocephalus sp.

9r (about 125 feet below 9t; about 115 feet below 9p; see 9v). (For stratigraphic position and association, see p. 142.) Upper Cambrian: About 45 feet (14 m.) above the porphyry contact in the limestone of the Reagan sandstone, in SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W., 15 miles (24.2 km.) northwest of Fort Sill, Comanche County, Okla. (E. O. Ulrich, 1901).

*Obolus tetonensis ninus.
Lingulella similis.
Linnarssonella girtyi.
Acrotreta microscopica.
Agnostus sp.
Ptychoparia sp.

9s (believed to just overlie 9u). (For stratigraphic position and association, see p. 142.) Upper Cambrian: About 85 feet (26 m.) below the Arbuckle limestone, in the limestone of the Reagan sandstone, near middle of west half of sec. 13, T. 4 N., R. 13 W., 13 miles (20.8 km.) northwest of Fort Sill, Comanche County, Okla. (E. O. Ulrich, 1901).

Obolus tetonensis ninus.
Lingulella similis.
Lingulella (Lingulepis) acuminata.
Eoorthis wichitaensis.

9t (125 feet above 9r; 10 feet above 9p; 25 feet below 9u; see 9v). (For stratigraphic position and association, see p. 142.) Upper Cambrian: About 170 feet (52 m.) above the porphyry contact in the limestone of the Reagan sandstone, SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W., 15 miles (24.2 km.) northwest of Fort Sill, Comanche County, Okla. (E. O. Ulrich, 1901).

Obolus matinalis.
Obolus tetonensis ninus.
Lingulella similis.
Acrotreta microscopica.
Eoorthis indianola.
Ptychoparia sp.

9u (believed to just underlie 9s; 25 feet above 9t). (For stratigraphic position and association, see p. 142.) Upper Cambrian: About 195 feet (59.4 m.) above the porphyry contact in the limestone of the Reagan sandstone, in SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W., 15 miles (24.2 km.) northwest of Fort Sill, Comanche County, Okla. (E. O. Ulrich, 1901).

Obolus tetonensis ninus.
Lingulella similis.
Eoorthis indianola.
Eoorthis wichitaensis.
Syntrophia primordialis.
Agnostus sp.
Ptychoparia sp.

9v (150 feet below 9w; between 9r and 9t). (For stratigraphic position and association, see p. 142.) Upper Cambrian: Limestone of the Reagan sandstone about 250 feet (76 m.) below the Arbuckle limestone, SW. ¼ sec. 17, T. 4 N., R. 12 W., about 11 miles (17.7 km.) northwest of Fort Sill, Comanche County, Okla. (E. O. Ulrich, 1901).

Lingulella (Lingulepis) acuminata.
Linnarssonella girtyi.
Agnostus sp.
Agraulos sp.
Chariocephalus? sp.
Illænurus? sp.

9w (150 feet above 9v). (For stratigraphic position and association, see p. 142.) Upper Cambrian: Limestone of the Reagan sandstone about 100 feet (30.5 m.) below the Arbuckle limestone, SW. ¼ sec. 17, T. 4 N., R. 12 W., 11 miles (17.7 km.) northwest of Fort Sill, Comanche County, Okla. (E. O. Ulrich, 1901).

Eoorthis indianola.
Agnostus.

9x (almost same horizon as 9p). (For stratigraphic position and association, see p. 142.) Upper Cambrian: Sandstones lying between beds of quartzite underlying the 300 feet of limestone at the top of the Reagan sandstone, SW. ¼ sec. 17, T. 4 N., R. 12 W., about 11 miles (17.7 km.) northwest of Fort Sill, Comanche County, Okla. (E. O. Ulrich, 1901).

Dicellomus politus.

9z. (For stratigraphic position and association, see p. 142.) Upper Cambrian: Basal beds of the Arbuckle limestone, about 25 feet above the heavy bedded limestone, near the middle of the west half of sec. 13, T. 4 N., R. 13 W., about 13 miles (20.8 km.) northwest of Fort Sill, Comanche County, Okla. (E. O. Ulrich, 1901).

Eoorthis wichitaensis.
Dikellocephalus.

10a (see 106). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Sandy layers of the Rome formation in western railroad cut through Shooks Gap, in Bays Mountains, 10 miles (16.1 km.) southeast of Knoxville [see Keith, 1895, areal geology sheet], Knox County, Tenn. (C. D. Walcott, 1891).

*Obolus pandemia.
*Lingulella auga.
Lingulella similis.

10b. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Sandy layers of the Rome formation at the western end of the central railroad cut through Shooks Gap, in Bays Mountains, 10 miles (16.1 km.) southeast of Knoxville [see Keith, 1895, areal geology sheet], Knox County, Tenn. (C. D. Walcott, 1891).

Lingulella auga.

10c (50 feet below 10k). (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shales on west side of Barachois River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Obolus (Bröggeria) salteri.
Lingulella concinna.
Schizambon priscus?.
Acrotreta bisecta.

10d. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shales on west side of Barachois River, 0.125 mile (0.2 km.) north of Boisdale road, opposite McMullin's place, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Obolus (Bröggeria) salteri.
Lingulella concinna.
Schizambon priscus.
Acrotreta bisecta.

10e (50 feet above 10f). (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shales on the east branch of Barachois River, 0.5 mile (0.8 km.) north of the crossroad from Boisdale to Upper Leitches Creek, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Obolus (Bröggeria) salteri.
Lingulella concinna.
Schizambon priscus.
Acrotreta bisecta.
Acrotreta convexa.

10f (=10g; 50 feet below 10e). (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shales on the east branch of Barachois River, 0.75 mile (1.2 km.) north of the crossroad from Boisdale to Upper Leitches Creek, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Obolus (Bröggeria) salteri.
Lingulella concinna.
Schizambon priscus.
Acrothele sp.
Acrotreta bisecta.

10g (=10f). (For stratigraphic position and association, see p. 131.) (S. W. Loper, 1901.)

Obolus (Bröggeria) salteri.
Lingulella concinna.
Schizambon priscus.
Acrotreta bisecta.
Acrothyra proavia.

10h. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shale on small east branch of Barachois River, 0.75 mile (1.2 km.) north of the crossroad from Boisdale to Upper Leitches Creek, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Lingulella concinna.
Schizambon priscus.
Acrotreta bisecta.
Orusia lenticularis.

10i. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shale in high bank on west side of Barachois River, just north of the Boisdale road, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Obolus (Bröggeria) salteri.
Lingulella concinna.
Schizambon priscus.
Acrotreta convexa.

10k (50 feet above 10c). (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shale on west bank of Barachois River, about 0.25 mile (0.4 km.) north of the Boisdale road, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Schizambon priscus.

10l. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shale on east bank of Barachois River, 6 miles (9.6 km.) from Little Bras d'Or Lake, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Obolus (Bröggeria) salteri.
Lingulella concinna.
Schizambon priscus.
Acrotreta bisecta.
Acrotreta convexa.

10m (see 372a). (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shales 2 miles (3.2 km.) south of the Boisdale road from Upper Leitches Creek, toward the head of Barachois River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Obolus (Bröggeria) salteri.
Lingulella concinna.

10n. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shale in ravine on east side of Barachois Glen, 3 miles (4.8 km.) from Barachois, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Obolus (Bröggeria) salteri.
Lingulella concinna.
Acrotreta bisecta.

10o. (For stratigraphic position and association, see p. 132.) Middle? Cambrian: Arenaceous shales in the railroad cut on the shore of Bras d'Or Lake, at Barachois, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Obolus (Westonia) escasoni?.

10p (a little below 10q; see 344o). (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandstone just below the waterfall in Division E2b of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Obolus (Palæobolus) bretonensis.
Lingulella atava.
Lingulella collicia.
Lingulella triparilis.
Lingulella sp.
Lingulella (Lingulepis) gregwa.
Lingulella (Lingulepis) gregwa robusta.
Lingulella (Lingulepis) longinervis.
Acrothele avia.
Acrotreta gemmula.
Acrothyra proavia.
Acrothyra sera.
Acrothyra signata.
Acrothyra signata orta.
*Protorthis (Loperia) dugaldensis.

Matthew [1903, p. 25] gives the following as occurring in Division 2b:

Acrothyra signata tarda=Acrothyra sera.
Lingulepis longinervis.
Orthotheca.
Bradorona perspicator magna Matthew.

Bassler cites the following from this locality:

Bradoria acuta (Matthew).
Bradoria benepuncta (Matthew).
Bradoria ovalis (Matthew).
Bradoria perspicator (Matthew) ss.
Bradoria robusta (Matthew).
Bradoria spectator (Matthew).

10p′. (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandstone 0.25 mile (0.4 km.) from lower bridge, on Gregwa Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Lingulella (Lingulepis) gregwa.
Lingulella (Lingulepis) gregwa robusta.
Lingulella (Lingulepis) longinervis.
Acrothyra sera.

10p″. (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandstone on the small brook on the hill between the bridge over Indian River and McPhees Brook, Cape Breton, Nova Scotia (S. W. Loper, 1901).

Obolus (Palæobolus) bretonensis.
Lingulella (Lingulepis) gregwa.
Lingulella (Lingulepis) gregwa robusta.
Lingulella (Lingulepis) longinervis.
Acrothele avia.
Acrotreta gemmula.
Acrothyra sera.
Bradoria robusta (Matthew).
Bradoria obesa (Matthew).

10q (a little above 10p; see 344o). (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandstone below the waterfall in Division E2b of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Acrothyra proavia.

Matthew [1903, p. 25] cites the following species from Division 2b:

Acrothyra signata tarda=Acrothyra sera.
Lingulepis longinervis.
Orthotheca.
Bradorona perspicator magna Matthew.

Bassler cites the following from this locality:

Bradoria elongata n. sp.

10r. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Arenaceous shales of Division C3a? of Matthew at McAdam shore, East Bay, east of Bras d'Or Lake, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Obolus (Bröggeria) salteri.
Obolus (Palæobolus) bretonensis.
Obolus (Westonia) escasoni?.
*Lingulella lens.

10s. (For stratigraphic position and association, see p. 132.) Middle Cambrian: Sandstone on McLean Brook, near Marion Bridge, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Lingulella cania.
Lingulella (Lingulepis) exigua.
Beyrichona triceps Matthew.

10t. (For stratigraphic position and association, see p. 132.) Middle Cambrian: Sandstone on McLean Brook, near Marion Bridge, eastern Cape Breton, Nova Scotia (S. W. Loper, 1901).

Lingulella (Lingulepis) exigua.

10v. Upper Cambrian: Shales in the "St. Croix sandstone" at Fox Glen, about 8 miles (12.8 km.) east of Baraboo, Baraboo quadrangle (U. S. G. S.), Sauk County, Wis.

*Obolus pheres.
Lingulella winona.
*Acrotreta nox.

10w. (For stratigraphic position and association, see p. 139.) Middle Cambrian: Shaly limestones about 5 miles (8 km.) northeast of Osceola, on the east side of the Snake Range, White Pine County, Nev. (C. D. Walcott, 1903).

Micromitra sculptilis.
Obolus mcconnelli.

10y (same horizon as 10z). (For stratigraphic position and association, see p. 155.) Middle Cambrian: About 2,900 feet (884 m.) above the Lower Cambrian and 1,500 feet (457.2 m.) below the Upper Cambrian, in the central part of the limestone forming 1a of the Marjum limestone [Walcott, 1908f, p. 179], about 1 mile (1.6 km.) south-southwest of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (C. D. Walcott and F. B. Weeks, 1903).

Micromitra sculptilis.
Obolus mcconnelli.
Lingulella arguta.
Acrothele subsidua.
Acrotreta attenuata.
Agnostus.
Ptychoparia.
Anomocare.

10z (same horizon as 10y). (For stratigraphic position and association, see p. 155.) Middle Cambrian: About 2,900 feet (884 m.) above the Lower Cambrian and 1,500 feet (457.2 m.) below the Upper Cambrian, in the central part of the limestone forming 1a of the Marjum limestone [Walcott, 1908f, p. 179], in the long cliff about 2 miles (3.2 km.) southeast of Marjum Pass [see Walcott, 1908f, Pls. XIII and XV], House Range, Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1903 and 1905).

*Dicellomus prolificus.
*Acrotreta bellatula.
Agnostus 2 sp.
Ptychoparia 2 sp.
Agraulos.
Anomocare.

11. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Sandstones and shales of the Rome formation, about 1 mile (1.6 km.) east of Post Oak Springs [see Hayes, 1894, areal geology sheet], Roane County, Tenn. (C. D. Walcott, 1891).

Lingulella ino.
*Lingulella tarpa.

11a. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Sandstone between First and Armstrong creeks, in the southeast corner of the Maynardville quadrangle (U. S. G. S.), Union County, Tenn. (C. D. Walcott, 1891).

Obolus sinoe.
Lingulella tarpa.
Dicellomus appalachia.

11c. Upper Cambrian: Hardyston quartzite [Weller, 1900, pp. 110 and 112], O'Donnell and McManniman's quarry, Newton, Sussex County, N. J. (H. E. Dickhaut, 1901).

*Lingulella welleri.

Weller [1900, p. 12] cites the following from this locality:

Foraminifera?.
Lingulella stoneana=Obolus (Westonia) stoneanus.
*Orthis newtonensis=Eoorthis newtonensis.
Microdiscus? sp.
Olenellus? sp.
Ptychoparia newtonensis Weller.
Ptychoparia 2 sp. undt.
Anomocare parvula Weller.
Dikellocephalus newtonensis Weller.

11d. (For stratigraphic position and association, see p. 137). Upper Cambrian: Arenaceous limestone about 2 miles (3.2 km.) north of Montana, in sec. 22, T. 35 N., R. 1 E., Iron County, Mo. (D. K. Greger).

Obolus matinalis?.
Billingsella coloradoensis.
Eoorthis remnicha texana?.

11e. (For stratigraphic position and association, see p. 137.) Middle Cambrian: In thin-bedded limestones south-southwest of Potosi, Washington County, Mo. (D. K. Greger).

Obolus matinalis?.
Lingulella similis.
Lingulella sp.
Linnarssonella girtyi.
Acrotreta microscopica missouriensis.
Billingsella coloradoensis.

11j. (For stratigraphic position and association, see p. 137.) Middle Cambrian: Basal part of Bonneterre limestone, Mine Lamotte, Madison County, Mo. (E. O. Ulrich, 1904).

*Obolus lamborni.
Obolus sinoe.
Lingulella acutangula.
Dicellomus nanus.

11k. (For stratigraphic position and association, see p. 137.) Middle Cambrian: In sandstones and limestones of the "Edgewise beds," St. Francois County, Mo. (F. Nason, 1901).

Lingulella acutangula.
Linnarssonella girtyi.
*Acrotreta microscopica missouriensis.

11l. (For stratigraphic position and association, see p. 137.) Upper Cambrian: Arenaceous limestone of the Elvins formation, 50 feet (15.2 m.) above the "Edgewise beds," St. Francois County, Mo. (F. Nason, 1901).

Lingulella acutangula?.
Billingsella coloradoensis.
Eoorthis remnicha texana?.

11m. (For stratigraphic position and association, see p. 137.) Middle Cambrian: Drill cores of limestone in the Bonneterre limestone, at horizons 10 and 20 feet (3 and 6 m.) above the Lamotte sandstone, at Flat River, St. Francois County, Mo. (F. Nason, 1901).

Micromitra sp.
Micromitra (Paterina) cf. stissingensis.
Obolus lamborni.
Lingulella cf. ora.
Dicellomus nanus.
Dicellomus politus.

11n. (For stratigraphic position and association, see p. 155.) Middle Cambrian: About 3,000 feet (914.4 m.) above the Lower Cambrian and 1,400 feet (426.7 m.) below the Upper Cambrian, in the upper part of the limestone forming 1a of the Marjum limestone [Walcott, 1908f, p. 179], in the long cliff 2 miles (3.2 km.) southeast of Marjum Pass [see Walcott, 1908f, Pls. XIII and XV], House Range, Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1903 and 1905).

Obolus meconnelli pelias.
*Obolus (Fordinia) gilberti.
Acrotreta bellatula.
*Acrotreta marjumensis.
*Acrotreta cf. sagittalis.
Agnostus 4 sp.

11o. (For stratigraphic position and association, see p. 155.) Middle Cambrian: About 2,750 feet (838.2 m.) above the Lower Cambrian and 1,650 feet (502.9 m.) below the Upper Cambrian, in limestone at the base, 1a, of the Marjum limestone [Walcott, 1908f, p. 179], about 4 miles (6.4 km.) southeast of Antelope Springs, in the spur at the junction of the Deseret and Swasey Spring roads [Walcott, 1908f, Pl. XIII], House Range, Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1903 and 1905).

Micromitra (Iphidella) pannula ophirensis.
Obolus mcconnelli pelias.
Obolus rotundatus.
Acrotreta idahoensis.
Annelid trails.
Stenotheca sp.
Hyolithes.
Bathyuriscus?.
Ptychoparia 2 sp.
Anomocare.

11p. (For stratigraphic position and association, see p. 156.) Middle Cambrian: About 2,000 feet (609.6 m.) above the Lower Cambrian and 2,400 feet (731.5 m.) below the Upper Cambrian, in the limestones forming 1e of the Marjum limestone [Walcott, 1908f, p. 181], in the long cliff about 2.5 miles (4 km.) southeast of Marjum Pass [Walcott, 1908f, Pls. XIII and XV], House Range, Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1905).

Linnarssonella sp.
Sponge spiculæ.
Agnostus, several sp.
Ogygopsis?.
Ptychoparia 2 sp.

11q (=11y and 30g; same horizon as 3w). (For stratigraphic position and association, see p. 156.) (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1903 and 1905.)

*Obolus mcconnelli pelias.
Lingulella arguta.
Acrothele subsidua.
Nisusia (Jamesella) nautes?.
Nisusia (Jamesella) spencei.
Eoorthis thyone.
Neolenus inflatus Walcott.
Neolenus intermedius Walcott.
Neolenus intermedius pugio Walcott.
Neolenus superbus Walcott.
Ogygopsis?.

11s. (For stratigraphic position and association, see p. 157.) Middle Cambrian: Shales just above Simpson Spring, about 20 miles (32.2 km.) west-southwest of Vernon, on the stage road from Vernon to Fish Spring, Tooele County, Utah (C. D. Walcott, 1903).

Obolus (Westonia) ella?.
Micromitra sculptilis.

11u. (For stratigraphic position and association, see p. 156.) Middle Cambrian: Lower portion of the shales forming the Wheeler formation, in Rainbow Valley, House Range [see Walcott, 1908f, Pl. XIII], Millard County, Utah (C. D. Walcott, 1903).

Acrothele subsidua.

11w (=30c). (For stratigraphic position and association, see p. 157.) Middle Cambrian: About 1,050 feet (320 m.) above the Lower Cambrian and 3,350 feet (1,021.1 m.) below the Upper Cambrian, in the shales forming 1d of the Swasey formation [Walcott, 1908f, p. 182], at the head of Dome Canyon, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (C. D. Walcott and F. B. Weeks, 1903).

Lingulella arguta.
Ptychoparia.

11x (=3x). (For stratigraphic position and association, see p. 156.) (C. D. Walcott, 1903.)

Obolus rotundatus.
Lingulella arguta.

11y (=11q and 30g). (For stratigraphic position and association, see p. 156.) (C. D. Walcott, 1903.)

Lingulella arguta.
Acrothele subsidua.
Acrotreta cf. ophirensis.

11z. (For stratigraphic position and association, see p. 132.) Middle Cambrian: Sandstone on Big Ridge 2 miles (3.2 km.) south of Marion Bridge, on the canal of John McDougald, eastern Cape Breton, Nova Scotia (S. W. Loper).

Obolus (Westonia) escasoni.
Lingulella (Lingulepis) exigua.

12. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Sandy shale on Webbs Ridge, in gap west of Simpson's farm, 6 miles (9.6 km.) northeast of Knoxville, Knox County, Tenn. (C. D. Walcott, 1891).

Linnarssonella tennesseensis.

12j (50 feet below 12g; 40 feet above 12i). (For stratigraphic position and association, see p. 142.) Upper Cambrian: Lower part of Arbuckle limestone, second fossiliferous horizon in the section at Small Hill, 2 miles (3.2 km.) southwest of Signal Mountain, about 8 miles (12.8 km.) west of Fort Sill, Comanche County, Okla. (E. O. Ulrich, 1901).

Eoorthis wichitaensis.
Agraulos sp.
Dikellocephalus sp.
Ptychaspis sp.
Illænurus sp.

12k (15 feet below 12n in Springer section). (For stratigraphic position and association, see p. 142.) Upper Cambrian: Limestone of the Reagan sandstone, about 225 feet (69 m.) above the porphyry contact and 55 feet (17 m.) below the Arbuckle limestone, on the west side of Honey Creek, near southeast corner sec. 35, T. 1 S., R. 1 E., 7 miles (11.2 km.) north of Springer, Ardmore quadrangle (U. S. G. S.), Carter County, Okla. (E. O. Ulrich, 1901).

Obolus tetonensis ninus.
Lingulella similis.
Acrotreta microscopica.
*Eoorthis indianola.
Eoorthis remnicha.
Eoorthis wichitaensis.
Eoorthis wichitaensis læviusculus.
Chariocephalus sp.

12m. (For stratigraphic position and association, see p. 142.) Upper Cambrian: Arbuckle limestone [in the section 7 miles (11.2 km.) north of Springer this horizon is about 30 feet (9.1 m.) above the Reagan sandstone], NE. ¼ sec. 2, T. 2 S., R. 1 E., Ardmore quadrangle (U. S. G. S.), Carter County, Okla. (E. O. Ulrich, 1901).

Obolus tetonensis ninus.
Lingulella similis.
Eoorthis remnicha texana.
Agraulos sp.
Ptychaspis sp.

12n (15 feet above 12k in Springer section). (For stratigraphic position and association, see p. 142.) Upper Cambrian: Limestone of the Reagan sandstone about 240 feet (73 m.) above the porphyry contact and 40 feet (12 m.) below the Arbuckle limestone, NW. ¼ sec. 1, T. 2 S., R. 1 E., 7 miles (11.2 km.) north of Springer, Ardmore quadrangle (U. S. G. S.), Carter County, Okla. (E. O. Ulrich, 1901).

Obolus tetonensis ninus.
Lingulella similis.
Lingulella (Lingulepis) acuminata.
Acrotreta microscopica.
Eoorthis indianola.
Eoorthis remnicha.
Eoorthis remnicha texana.
Eoorthis wichitaensis.
Eoorthis wichitaensis læviusculus.
Syntrophia primordialis.
Ptychoparia sp.
Chariocephalus sp.

12p. (For stratigraphic position and association, see p. 142.) Upper Cambrian: About 225 feet (69 m.) above the igneous rocks in the limestone of the Reagan sandstone, at the northwest extremity of the Arbuckle Mountains, about 4 miles (6.4 km.) east of Homer, Carter County, Okla.

Obolus tetonensis ninus.
Lingulella similis.
Lingulella (Lingulepis) acuminata.
Acrotreta curvata.
Acrotreta microscopica.
*Acrotreta ulrichi.
Linnarssonella girtyi.
Eoorthis indianola.
Eoorthis remnicha.
*Eoorthis wichitaensis.
*Eoorthis wichitaensis læviusculus.
Agraulos sp.
Ptychoparia sp.
Chariocephalus sp.
Illænurus sp.

12q. (For stratigraphic position and association, see p. 147.) Upper Cambrian: Knox dolomite on Bunker Hill, 6 miles (9.6 km.) northeast of Rogersville [see Keith, 1905, areal geology sheet], Hawkins County, Tenn. (M. R. Campbell, 1892).

*Syntrophia campbelli.

12v. Lower Cambrian: Sandstone above the quartzite 1 mile (1.6 km.) west of Fruitville, on Little Conestoga Creek, Manheim Township, Lancaster County, Pa. (C. D. Walcott, 1909).

Obolella crassa?

13. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Sandstones of the Rome formation 1.5 miles (2.4 km.) east of Post Oak Springs [see Hayes, 1894, areal geology sheet], Roane County, Tenn. (C. D. Walcott, 1891).

Lingulella ino.
*Linnarssonella tennesseensis.

13b. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Sandstones of the Rome formation northeast of Rhea Springs [see Hayes, 1894, areal geology sheet], Roane County, Tenn. (C. D. Walcott, 1891).

Micromitra (Paterina) crenistria.
*Lingulella ino.

13c. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Sandstones of the Rome formation, west side of the sandstone ridge about 2.5 miles (4 km.) southwest of Rome [see Hayes, 1902, historical geology sheet], Floyd County, Ga. (C. D. Walcott, 1891).

Lingulella ino.

13d (=13d′). (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandstones opposite the third waterfall in Dugald Brook, between Divisions E2a and E2b of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Lingulella (Lingulepis) longinervis.
Acrothele avia.
Bradoria robusta (Matthew).

13d′ (=13d). (For stratigraphic position and association, see p. 134.) (S. W. Loper, 1903.)

Obolus (Palæobolus) bretonensis.
Lingulella atava.
Lingulella collicia.
Acrothele avia.
Acrothyra sera.
Acrothyra signata.

13d″ (see 13p, 13g, 13f, and 13p′). (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandstones 10 feet (3 m.) below Division E2a of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Lingulella (Lingulepis) longinervis.
Acrothele avia.
Acrothele prima.
Acrothyra signata orta.

Bassler cites the following from this locality:

Bradoria benepuncta (Matthew).
Bradoria perspicator (Matthew) (ss).
Bradoria robusta (Matthew).
Bradoria rugulosa Matthew (emend.).

13e (see 344 l). (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandstones of Division E2c of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Obolus (Palæobolus) bretonensis lens.
Acrothyra proavia.
Acrothyra sera.

Matthew [1903, p. 25] gives the following fauna occurring in 2c:

Acrothyra signata orta.
Bradorona observator lævis Matthew.

13f (see 13p, 13g, 13d″, and 13p′). (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandstones 20 feet (6 m.) above Division E2a of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Lingulella (Lingulepis) longinervis.
Acrothyra sera.

13g (see 13p, 13f, 13d″, and 13p′). (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandstones 10 feet (3 m.) above Division E2a of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Lingulella (Lingulepis) longinervis.

Bassler cites the following species from this locality:

Hymenocaris? matthewi n. sp.

13h. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shale on east bank of Barachois River, 1.5 miles (2.4 km.) north of Boisdale, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Obolus (Bröggeria) salteri.
Lingulella concinna.
Schizambon priscus.
Acrotreta bisecta.

13i (little different horizon than 13r). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Sandstone of the "Johannian" Division of Matthew's section, on Gillis Brook, East Bay, east of Bras d'Or Lake, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Lingulella tumida.

13k (see 344f). (For stratigraphic position and association, see p. 135.) Middle Cambrian: Shales of Matthew's [1903, p. 15] Coldbrook, above the great falls in Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Micromitra (Iphidella) pannula?.
*Obolus? torrentis.
Lingulella (Lingulepis?) pumila?.
Acrothyra sera.
*Acrothyra signata prima.

13l (=13l′). (For stratigraphic position and association, see p. 133.) (S. W. Loper, 1903.)

Obolus (Palæobolus) bretonensis lens.
Lingulella (Lingulepis) longinervis.
Acrothele avia.
Acrothyra proavia.

131′ (=131; see 344i). (For stratigraphic position and association, see p. 133.) Middle Cambrian: In the shaly sandstones of Division E3a of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Obolus (Palæobolus) bretonensis.
Lingulella atava.
Acrothele avia.
Acrothele proles.

Matthew [1903] cites the following from this locality:

Obolus lens (pp. 58, 80).
Obolus (Palæobolus) bretonensis (p. 26).
Lingula sp.
Leptobolus sp.
Acrothele abavia.
Acrothyra proavia (p. 57).
*Acrothyra proavia prima.

Bassler cites the following from this locality:

Bradoria acuta (Matthew).
Bradoria curta Bassler.

13m. (For stratigraphic position and association, see p. 133.) Middle Cambrian: Sandstones of Division E3f of Matthew's [1903, p. 76] Etcheminian, on Gillis Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Obolus (Palæobolus) bretonensis lens.
Lingulella collicia.
Acrothele avia.
*Acrothele proles.

Matthew [1903] cites the following:

Leptobolus collicia=Lingulella collicia.
Leptobolus collicia collis=Liugulella collicia.
Acrothele avia puteis.
Acrothele proles.
Acrothyra proavia crassa=Acrothyra proavia.
Acrothyra proavia prima=Acrothyra proavia.
Leperditia?? rugosa.
Bradoria scrutator.

Bassler cites the following from locality No. 13m″:

Bradoria acuta (Matthew).
Bradoria vigilans Matthew.
Beyrichona rutellum (Matthew).

13n (see 344d). (For stratigraphic position and association, see p. 133.) Middle Cambrian: Sandstones of Division E3f of Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Lingulella atava.
Acrothele avia.
Acrothele proles.

Matthew [1903, p. 37] cites the following:

Leptobolus atavus=Lingulella atava.
Leptobolus collicia=Lingulella collicia.
Leptobolus collicia collis=Lingulella collicia.
Acrothele proles.
Acrothyra crassa?=Acrothyra proavia.
Acrothyra proavia prima?=Acrothyra proavia.
Bradorona perspicator major.
Bradorona scrutator.
Solenopleura (?) bretonensis (part).

Bassler cites the following:

Bradoria scrutator (Matthew).
Indiana lippa (Matthew).
Walcottella fusiformis (Matthew).

13n′. (For stratigraphic position and association, see p. 133.) Middle Cambrian: Sandstones of Division E3e of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

*Obolus (Palæobolus) bretonensis lens.
*Lingulella atava.
*Lingulella collicia.
*Lingulella tumida.
*Acrothele avia.
Acrothyra proavia.

Matthew [1903, p. 27] cites the following:

Obolus lens.
Obolus lens longus.
Lingulella tumida.
Lingulella sp.
Leptobolus atavus.
Leptobolus collicia.
Acrothele abavia.
Acrothele avia.
Acrothyra proavia.
Acrothyra proavia crassa.
Indiana ovalis.
Bradorona observator ligata.
Bradorona scrutator.
Bradoria rugulosa.
Bradoria vigilans.
Schmidtella? acuta.
Schmidtella? pervetus.

Bassler cites the following:

Indiana lippa (Matthew).
Bradoria robusta (Matthew).
Bradoria rugulosa Matthew.
Bradoria scrutator (Matthew).
Bradoria vigilans Matthew
Bradoria ovalis Matthew.
Bradoria acuta (Matthew).

13n″ (see 344b). (For stratigraphic position and association, see p. 133.) Middle Cambrian: Sandstones of Division E3d of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, Cape Breton, Nova Scotia (S. W. Loper, 1903).

Obolus (Palæobolus) bretonensis.
Lingulella atava.
Acrothyra proavia.

Matthew [1903, p. 26] cites the following:

Obolus bretonensis.
Leptobolus atavus.
Acrothele avia.
Bradorona spectator æquat.

Bassler cites the following:

Bradoria acuta (Matthew).
Bradoria elongata n. sp.
Bradoria obesa (Matthew).
Bradoria robusta (Matthew).
Bradoria vigilans Matthew.

13p (see 13g, 13f, 13d″, and 13p′). (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandstones 40 feet (12.2 m.) above Division E2a of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Lingulella (Lingulepis) longinervis.
Acrothyra sera?.

13p′ (see 13p, 13g, 13f, and 13d″.) (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandstone 45 feet (13.6 m.) above Division E2a of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Lingulella (Lingulepis) longinervis.
Acrothyra sera?.

13q. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shales of the "Bretonian" division of Matthew's [1903, p. 45] section on Gillis Brook, East Bay, Cape Breton, Nova Scotia (S. W. Loper, 1903).

Orusia lenticularis.
Bradoria robusta (Matthew).

13r (little different horizon from 13i). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Sandstone of the "Johannian" division of Matthew's section on Gillis Brook, East Bay, east of Bras d'Or Lake, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Lingulella tumida.
Lingulella (Lingulepis) exigua.

13t. (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandstones at the base of Division E1b of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

*Lingulella triparilis.
Lingulella tumida.
Acrothele prima.
Acrothyra signata.

Bassler cites the following:

Bradoria rugulosa Matthew (emend.).
Bradoria robusta (Matthew).
Bradoria robusta n. var.

13t′ (same locality as 10p; see 344k). (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandstones of Division E1b of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Lingulella triparilis.

13t″ (see 344m). (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandstones of Divisions E1c and E1d of Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Lingulella triparilis.
Lingulella (Lingulepis) gregwa.
Acrothyra sera.
Acrothyra signata.
Bradoria robusta (Matthew).
Bradoria concinna (Matthew).

Matthew [1903] cites the following as occurring in 1d:

Lingulepis gregwa.
Lingulepis gregwa robusta.
Acrotreta papillata=Acrothyra sera.
Acrotreta signata tarda=Acrothyra sera.
Orthotheca sp.
Bradorona observator Matthew.
Bradorona observator benepuncta Matthew.
Bradorona perspicator Matthew.
Bradorona spectator Matthew.
Bradorona spectator acuta Matthew.

14. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestones overlying the sandstones of the Rome formation, near the wagon road and in a quarry near the railroad track, 7 miles (11.2 km.) southwest of Rome [see Hayes, 1902, historical geology sheet], Floyd County, Ga. (C. D. Walcott, 1891).

Micromitra (Iphidella) pannula.
Billingsella appalachia?
Dorypyge?.

14a. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Sandstone of the Rome formation, along First Creek Gap, 4 miles (6.4 km.) north-northeast of Knoxville [Keith, 1905, areal geology sheet], Knox County, Tenn. (M. R. Campbell, 1891).

Micromitra alabamaensis.
Obolus willisi.
Obolus (Westonia) ella.
Lingulella similis.
*Wimanella saffordi.

14b. Upper Cambrian: Limestone on Cold Creek, at north end of gorge opposite the north end of Sponge Mountain, 2 miles (3.2 km.) south of the San Saba County line, in Llano County, Tex. (J. A. Taff, E. O. Ulrich, and J. W. Beede).

Obolus matinalis.
*Obolus nundina.
Obolus sinoe.
Lingulella acutangula.
Lingulella upis.
Lingulella (Lingulepis) acuminata.
Acrotreta microscopica.
Billingsella coloradoensis.
Eoorthis indianola?.
Eoorthis remnicha texana.
Eoorthis wichitaensis.
Eoorthis wichitaensis læviusculus.

14c. Upper Cambrian: Upper part of the limestone exposed at Baldwin's ranch, on Cold Creek, 2.5 miles (4 km.) south of the San Saba County line, in Llano County, Tex. (E. O. Ulrich).

Obolus matinalis.

14e (see 14q). Upper Cambrian: Limestone in Bartlett Hollow, 2 miles (3.2 km.) southeast of the mouth of Falls Creek, Burnet quadrangle (U. S. G. S.), Lampasas County, Tex. (Bailey Willis, E. O. Ulrich, and J. A. Taff).

Obolus matinalis.
Obolus sinoe.
Acrotreta microscopica.

14g (=14i). (E. O. Ulrich, J. A. Taff, and J. W. Beede.)

Lingulella upis.
Acrotreta microscopica.
Billingsella coloradoensis.

14i (=14g). Upper Cambrian: Upper part of limestone exposed 1 mile (1.6 km.) west of Cherokee, San Saba County, Tex. (E. O. Ulrich, J. A. Taff, and J. W. Beede).

Lingulella acutangula.
*Lingulella upis.
Linnarssonella girtyi.

14k. Upper Cambrian: Limestone on Wolf Creek, 15 miles (24.2 km.) west-southwest of Sheridan, Bighorn Mountains, Sheridan County, Wyo.

Eoorthis desmopleura.
*Syntrophia rotundata.

14l. (For stratigraphic position and association, see p. 138.) Lower Cambrian: Sandstones about 2,800 feet (853 m.) below the Middle Cambrian, in a horizon correlated with No. 2j of the Silver Peak group of the Waucoba Springs section [Walcott, 1908f, p. 187], in the pass about 7 miles (11.2 km.) east of Resting (Freshwater) Springs, which is in the southwest corner of T. 21 N., R. 8 E., on Amargosa River, in the southeastern part of Inyo County, Cal. (R. B. Rowe, 1901).

*Billingsella bivia.
Olenellus fremonti Walcott

14m. (For stratigraphic position and association, see p. 140.) Middle Cambrian: Limestone about 7 miles (11.2 km.) south of Towner's ranch, Indian Creek, Lincoln County, Nev. (R. B. Rowe, 1901).

Lingulella arguta.

14n. Middle Cambrian: Limestone about 310 feet (94.5 m.) above the Lower Cambrian, on the east side of the pass about 7 miles (11.2 km.) east of Resting (Freshwater) Springs, which is the southwest corner of T. 21 N., R. 8 E., on Amargosa River, in the southeastern part of Inyo County, Cal. (R. B. Rowe, 1901).

Obolus mcconnelli.
Obolus mcconnelli decipiens.

14o. (For stratigraphic position and association, see p. 138.) Lower Cambrian: Sandstones about 3,500 feet (1,067 m.) below the Middle Cambrian, in the pass about 7 miles (11.2 km.) east of Resting (Freshwater) Springs, which is the southwest corner of T. 21 N., R. 8 E., on Amargosa River, in the southeastern part of Inyo County, Cal. (R. B. Rowe, 1901).

Obolella sp. undt.

14p. (For stratigraphic position and association, see p. 138.) Lower Cambrian: Reddish-brown quartzitic sandstone near Resting (Freshwater) Springs, which is in the southwest corner of T. 21 N., R. 8 E., on Amargosa River, in the southeastern part of Inyo County, Cal. (M. R. Campbell and R. B. Rowe, 1901).

*Lingulella (Lingulepis) rowei.
Obolella vermilionensis.
Billingsella bivia.
Wanneria gracile Walcott.
Olenellus fremonti Walcott.
Cystid plate.

14q (see 14e). Upper Cambrian: Sandstone in Bartlett Hollow, 1.5 miles (2.4 km.) southeast of the mouth of Falls Creek, Burnet quadrangle (U. S. G. S.), Lampasas County, Tex. (E. O. Ulrich).

Obolus matinalis.

14r. Upper Cambrian: Sandstone in the lower part of the beds exposed on Colorado River, 3 miles (4.8 km.) south of the northeast corner of Llano County, Tex. (E. O. Ulrich).

Obolus matinalis.
Lingulella (Lingulepis) acuminata.

14s. (For stratigraphic position and association, see p. 127.) Middle Cambrian: About 2,300 feet (701 m.) above the Lower Cambrian and 2,700 feet (823 m.) below the Upper Cambrian, in the *Ogygopsis* zone of the Stephen formation [Walcott, 1908f, p. 210], at the great "fossil bed" on the northwest slope of Mount Stephen, above Field on the Canadian Pacific Railway, British Columbia, Canada (W. D. Wilcox, 1894; Mr. and Mrs. C. D. Walcott and Mr. and Mrs. L. D. Burling, 1907).

Micromitra (Iphidella) pannula.
Micromitra (Iphidella) pannula ophirensis.
*Obolus mcconnelli.
*Obolus septalis.
Acrothele colleni.
*Acrotreta depressa.
*Philhedra columbiana.
*Nisusia alberta.
Hyolithellus annulatus (Matthew).
Hyolithellus flagellum (Matthew).
Orthotheca corrugata Matthew.
Orthotheca major Walcott.
Hyolithes carinatus Matthew.
Hyolithes sp.
Stenotheca wheeleri Walcott.
Platyceras bellianus Walcott.
Platyceras romingeri Walcott.
Scenella varians Walcott.
Anomalocaris?? acutangula Walcott.
Anomalocaris canadensis Whiteaves.
Anomalocaris? whiteavesi Walcott.
Agnostus montis Matthew.
Dorypyge (Kootenia) dawsoni (Walcott).
Bathyuriscus occidentalis (Matthew).
Bathyuriscus ornatus Walcott.
Bathyuriscus pupa Matthew.
Bathyuriscus rotundatus (Rominger).
Karlia stephenensis Walcott.
Neolenus granulatus Matthew=Neolenus serratus.
Neolenus serratus (Rominger).
Ogygopsis klotzi (Rominger).
Oryctocephalus reynoldsi Reed.
Oryctocephalus walkeri Matthew=Oryctocephalus reynoldsi.
Burlingia hectori Walcott.
Ptychoparia cordilleræ (Rominger).
Ptychoparia palliseri Walcott.
Zacanthoides spinosus (Walcott).

14t. (For stratigraphic position and association, see p. 157.) Middle Cambrian: Limestone lying on slope between the Cambrian quartzite and the massive blue limestone 100 feet (30.5 m.) above, Mount Nebo Canyon, 3 miles (4.8 km.) southeast of Mona, Juab County, Utah (F. B. Weeks, 1903).

Micromitra (Iphidella) pannula.
Lingulella cf. similis.
*Acrotreta neboensis.

14v. (For stratigraphic position and association, see p. 156.) Middle Cambrian: Shales of unknown stratigraphic horizon collected 1 mile (1.6 km.) south of Rainbow Valley, House Range [see Walcott, 1908f, Pl. XIII], Millard County, Utah.

Obolus mcconnelli.

14x. Middle Cambrian: About 400 feet (122 m.) above the bottom of Tombstone Gulch, in the Abrigo limestone [Ransome, 1904, p. 3], in the northwest suburb of Bisbee [see Ransome, 1904, areal geology sheet], Cochise County, Ariz. (F. L. Ransome, 1903).

Obolus tetonensis.
Billingsella??.

15b. (For stratigraphic position and association, see p. 156.) Middle Cambrian: About 1,700 feet (518.2 m.) above the Lower Cambrian and 2,700 feet (823 m.) below the Upper Cambrian, in the shaly limestones and calcareous shales of the Wheeler formation [Walcott, 1908f, p. 181], near Swasey Spring, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (G. K. Gilbert, 1903).

Acrothele subsidna.

15c. (For stratigraphic position and association, see p. 156.) Middle Cambrian: Marjum limestone [Walcott, 1908a, p. 10], near Swasey Spring, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (G. K. Gilbert, 1901).

Nisusia (Jamesella) nautes?.
Anomocare sp.

15d (same horizon as 33d). (For stratigraphic position and association, see p. 154.) Upper Cambrian: Thin-bedded blue limestone near Cave Spring, on the east side of the Fish Spring Range, about 4 miles (6.4 km.) south of the J. J. Thomas ranch, Juab County, Utah (G. K. Gilbert, 1901).

Lingulella desiderata.
*Lingulella isse.
Lingulella manticula.
Acrotreta idahoensis.
Acrotreta idahoensis alta.

15p. (For stratigraphic position and association, see p. 155.) Middle Cambrian: Limestones near the north end of the Fish Spring Range, Tooele County, Utah (G. K. Gilbert, 1901).

Obolus mcconnelli pelias.
Lingulella desiderata.

15r. Middle Cambrian: Dark argillaceous shale at Khussak, Salt Range, India (F. Noetling, 1902).

*Lingulella fuchsi.
*Lingulella wanniecki.
*Botsfordia granulata.
Redlichia nœtlingi Cossman.

15x. (For stratigraphic position and association, see p. 155.) Middle Cambrian: Limestones near the middle of the Fish Spring Range, near the line between Juab and Tooele counties, Utah (G. K. Gilbert, 1901).

Obolus mcconnelli pelias.
Lingulella desiderata.

16. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestones in Conasauga ("Coosa") limestone, Blountsville Valley, Blount County, Ala.

Lingulella desiderata.
*Lingulella nanno.
Dicellomus appalachia.

16f (see 47d–f). Lower Cambrian: Sandstone at the mouth of Little Antietam Creek, near Eakles Mills, Washington County, Md. (John Widgeon, 1903).

Obolella minor.
Syntrophia sp. undt.

16h (see 334h). (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones of *Paradoxides forchhammeri* zone at Borregaard, Bornholm Island, Denmark (K. A. Grönwall, 1903).

*Micromitra pusilla.
Micromitra (Iphidella) ornatella.
Obolus schmalenseei.
Lingulella ferruginea.
Acrothele coriacea.
Acrothele intermedia.
Acrotreta sagittalis.
Acrotreta schmalenseei.
Anomocare læve Angelin.

16i. (For stratigraphic position and association, see p. 146.) Middle Cambrian: Limestones of "*Conocoryphe exsulans*" zone at Borregaard, Bornholm Island, Denmark (K. A. Grönwall, 1903).

Obolus schmalenseei.
Lingulella?.
Acrotreta sagittalis.
Liocephalus impressa Linnarsson.

16j. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones of *Paradoxides forchhammeri* zone at Laesaå, Bornholm Island, Denmark (K. A. Grönwall, 1903).

Micromitra pusilla.
Lingulella ferruginea.
Acrothele coriacea.
Acrotreta sagittalis.
Acrotreta schmalenseei.

16k. (For stratigraphic position and association, see p. 146.) Middle Cambrian: Limestones of *Paradoxides davidis* zone at Laesaå, Bornholm Island, Denmark (K. A. Grönwall, 1903).

Acrothele coriacea.
Acrotreta sagittalis.

16l. (For stratigraphic position and association, see p. 146.) Middle Cambrian: Limestones of *Paradoxides davidis* zone at Borregaard, Bornholm Island, Denmark (K. A. Grönwall, 1903).

Acrothele coriacea.
Acrotreta sagittalis.

16n. Upper Cambrian: Interformational conglomerate and shales in Adams pasture, 0.5 mile (0.8 km.) west of Main Street, on Lake Street, St. Albans, Franklin County, Vt. (Geo. H. Edson; H. E. Dickhaut, 1903).

Lingulella?.
Lingulella (Lingulepis) acuminata.
Yorkia sp.

16o. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shales on McMullins Brook, in the East Boisdale district, eastern Cape Breton, Nova Scotia (S. W. Loper, 1903).

Lingulella concinna.

17b. (For stratigraphic position and association, see p. 147.) Lower Cambrian: Rome ("Montevallo") formation 4 miles (6.4 km.) south of Helena, Shelby County, Ala. (C. D. Walcott, 1895).

Micromitra (Paterina) major.
Micromitra (Paterina) williardi.
Obolus smithi.
*Wimanella shelbyensis.

17c. Middle Cambrian: Sandy limestone 235 feet (71.6 m.) above the "Tonto" sandstone, Grand View trail north of Last Chance copper mine, south side of the Grand Canyon of the Colorado, Arizona.

*Obolus (Westonia) themis.
Lingulella acutangula.
Lingulella lineolata.

17j. Middle Cambrian: Limestone in the east end of the town of Galena, Black Hills, South Dakota.

Lingulella similis.

17k. Middle Cambrian: Limestone thrown out on the dump of the Great Northern shaft, southeast of Twobit, northern Black Hills, Lawrence County, South Dakota.

Linnarssonella girtyi.

18. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone 1 mile (1.6 km.) east of Gap Creek, 13 miles (20.8 km.) S. 75° E. of Knoxville, Knox County, Tenn. (A. Keith and C. D. Walcott).

Acrotreta kutorgai?.

20 (see 21a). Lower Cambrian: Limestone on the south side of Mettawee River, 0.25 mile (0.4 km.) above the North Granville bridge, Fort Ann quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1890).

Obolella crassa.
Medusa? sp.

20a. Lower Cambrian: Gray limestone interbedded with shaly slates in a lane west of Lafayette Stevens's house, about 100 yards (91.4 m.) from the main road in the southern part of Whitehall township, Fort Ann quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1890).

Lingulella granvillensis.
Acrotreta sagittalis taconica.
Hyolithellus micans (Billings).
Microdiscus connexus Walcott.
Olenellus?.
Olenoides fordi Walcott.
Ptychoparia sp.

21. Lower Cambrian: Shales 1.5 miles (2.4 km.) south of Salem, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1890).

Billingsella salemensis.
Archæocyathus dwighti Walcott.
Stenotheca rugosa (Hall).
Fordilla troyensis Barrande.
Microdiscus lobatus (Hall).
Olenellus.
Solenopleura? tumida Walcott.
Leperditia? dermatoides (Walcott).

21a. Lower Cambrian: Limestone below the first fall of Mettawee River, above the North Granville bridge, Fort Ann quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1890).

Lingulella granvillensis.
Microdiscus connexus Walcott.
Olenellus?.
Ptychoparia sp.

22. Lower Cambrian: Limestone 1.5 miles (2.4 km.) north of North Granville, Fort Ann quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1891).

Acrothele nitida.
Acrotreta sagittalis taconica.
Hyolithellus micans (Billings).
Microdiscus lobatus (Hall).
Olenellus.

22a. Lower Cambrian: Limestone in Penrhyn quarries, Middle Granville, Mettawee quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1890).

Lingulella sp.
Acrotreta sagittalis taconica.
Billingsella salemensis.

25. Lower Cambrian: Sandstone just above Parker's quarry, near Georgia, Franklin County, Vt. (C. D. Walcott and Cooper Curtice, 1883).

*Rustella edsoni.
Micromitra (Paterina) bella.
Nisusia festinata.
*Nisusia festinata transversa.
Medusa? sp.
Eocystites? sp.
*Mesonacis vermontana (Hall).
*Pædeumias transitans Walcott.
*Olenellus thompsoni (Hall).
Olenellus thompsoni crassimarginatus Walcott.
Microdiscus parkeri Walcott.
Ptychoparia adamsi (Billings).
Ptychoparia vulcanus (Billings).
Protypus senectus (Billings).
Bathynotus holopyga (Hall).
Olenoides marcoui (Whitfield).

25a. Lower Cambrian: Limestone on the Hall (Donaldson's) farm, 2 miles (3.2 km.) east of Swanton, Franklin County, Vt. (C. D. Walcott and Cooper Curtice, 1883).

*Micromitra (Paterina) labradorica swantonensis.
Obolus cf. prindlei.
Lingulella granvillensis.
Kutorgina cingulata.
Nisusia festinata.
Nisusia festinata transversa.
Billingsella orientalis.
Hyolithes sp.
Salterella pulchella Billings.
Olenellus thompsoni (Hall).
Ptychoparia adamsi (Billings).
Protypus senectus (Billings).

26. Lower Cambrian: Sandstone northeast of the Corman farm buildings, east of Highgate Springs, Franklin County, Vt. (C. D. Walcott and Cooper Curtice, 1883).

Micromitra (Paterina) labradorica swantonensis.
Nisusia festinata.
Billingsella orientalis.
Scenella varians Walcott.
Hyolithes sp.
Olenoides desiderata (Walcott).
Ptychoparia adamsi (Billings).
Ptychoparia teucer (Billings).
Ptychoparia vulcanus (Billings).
Ptychoparia sp.

27. Lower Cambrian: Even-bedded and conglomerate limestones on the ridge in the eastern suburb of Troy, Troy quadrangle (U. S. G. S.), Rensselaer County, N. Y. (Cooper Curtice, 1883).

Obolella crassa.
Bicia gemma.
Botsfordia cælata.
*Acrothele nitida.
Archæocyathus rarus (Ford).
Archæocyathus rensselæricum (Ford).
Scenella retusa Ford.
Stenotheca rugosa (Hall).
Platyceras primævum Billings.
Hyolithellus micans Billings.
Hyolithes americanus Billings.
Hyolithes communis Billings.
Hyolithes communis emmonsi Ford.
Hyolithes impar Ford.
Hyolithes sp.
Microdiscus lobatus (Hall).
Microdiscus speciosus Ford.
Elliptocephala asaphoides Emmons.
Olenoides fordi Walcott.
Solenopleura nana Ford.

27a. Lower Cambrian: Reddish sandstone about 1 mile (1.6 km.) east of Lansingburg, north of Troy, Cohoes quadrangle (U. S. G. S.), Rensselaer County, N. Y. (Cooper Curtice, 1883).

Obolella crassa.

28. Upper Cambrian: Shales about 100 feet (30.5 m.) above the *Olenellus* horizon, south of Highgate Falls, 0.25 mile (0.4 km.) east of Swanton, Franklin County, Vt. (C. D. Walcott, 1884).

*Protorthis wingi.
Hyolithes sp.
Ptychoparia adamsi (Billings.)

28a. Middle? Cambrian: "St. Albans formation," in limestone lentile about 1 mile (1.6 km.) east of Parker's quarry, near Georgia, Franklin County, Vt. (C. D. Walcott, 1884).

Lingulella franklinensis.
*Huenella billingsi.
Ptychoparia adamsi (Billings).

29 (see 338b). Lower Cambrian: Limestone just above the bridge at the Stockport paper mill, on Kinderhook Creek, Columbia County, N. Y. (C. D. Walcott and S. W. Ford).

Obolus prindlei.
Lingulella granvillensis.
Acrotreta sagittalis taconica.

29a (see 338). Lower Cambrian: Limestone 1 mile (1.6 km.) below the New York Central Railroad depot at Schodack Landing, Rensselaer County, N. Y. (C. D. Walcott and S. W. Ford).

Obolella crassa.
Botsfordia cælata.
Bicia gemma.
Acrotreta sagittalis taconica.
Hyolithellus micans (Billings).
Hyolithes americanus Billings.
Microdiscus lobatus (Hall).
Microdiscus speciosus Ford.
Elliptocephala asaphoides Emmons.

30. (For stratigraphic position and association, see p. 158.) Lower Cambrian: Limestone 8 miles (12.8 km.) north of Bennetts Spring, on the west slope of the Highland Range, Lincoln County, Nev. (C. D. Walcott and J. E. W., 1885).

Micromitra (Iphidella) pannula.
Obolus (Westonia) ella.
Billingsella highlandensis.
Callavia nevadensis Walcott.
Olenellus fremonti Walcott.
Olenellus gilberti (Meek).
Peachella iddingsi Walcott.
Sponge?.
Crepicephalus augusta Walcott.
Crepicephalus liliana Walcott.

30a. (For stratigraphic position and association, see p. 158.) Middle Cambrian: Shale on north side of Big Cottonwood Canyon, 1 mile (1.6 km.) below Argenta, in the Wasatch Mountains, southeast of Salt Lake City, Salt Lake County, Utah (C. D. Walcott and J. E. W., 1885).

Micromitra (Iphidella) pannula.
Obolus (Westonia) ella.
Lingulella helena.
Hyolithellus sp.
Hyolithes billingsi Walcott.
Isoxys argentea (Walcott).
Ptychoparia quadrans (Hall and Whitfield).
Bathyuriscus productus (Hall and Whitfield).
Olenoides wasatchensis (Hall and Whitfield).

Walcott [1886] wrongly includes *Cruziana* and *Olenellus gilberti* in this fauna (see Walcott, 1891b, p. 319).

30c (=IIw). (For stratigraphic position and association, see p. 157.) (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1905.)

Micromitra (Paterina) labradorica utahensis.
Ptychoparia 2 sp.

30d. (For stratigraphic position and association, see p. 157.) Middle Cambrian: About 1,020 feet (310.9 m.) above the Lower Cambrian and 3,400 feet (1,036.3 m.) below the Upper Cambrian, in the limestone forming 1e of the Swasey formation [Walcott, 1908f, p. 182], at the head of Dome Canyon, about 2 miles (3.2 km.) west-southwest of Antelope Springs, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (F. B. Weeks, 1905).

Obolus (Westonia) ella.
Ptychoparia, several species.

30e. (For stratigraphic position and association, see p. 158.) Middle Cambrian: About 100 feet (30.5 m.) above the Lower Cambrian and 4,300 feet (1,310.6 m.) below the Upper Cambrian, in the limestones forming 1a of the Langston (?) limestone [Walcott, 1908f, p. 183], in Dome Canyon, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1905).

Billingsella sp. undt.
Hyolithes.
Leperditia?.
Zacanthoides.
Ptychoparia.
Dorypyge?.

30g (=11q and 11y; same horizon as 3w). (For stratigraphic position and association, see p. 156.) Middle Cambrian: About 2,350 feet (716.3 m.) above the Lower Cambrian and 2,050 feet (624.8 m.) below the Upper Cambrian, in the limestone forming 1c of the Marjum limestone [Walcott, 1908f, p. 180], 2.5 miles (4 km.) east of Antelope Springs, in ridge east of Wheeler Amphitheater [Walcott, 1908f, Pls. XIII and XV], House Range, Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1905).

Obolus mcconnelli pelias.
Acrothele subsidua.
Acrotreta ophirensis.
Acrotreta cf. ophirensis.
Hyolithes.
Crinoidal fragments.
Sponge.
Ogygopsis?.
Agnostus 2 sp.
Ptychoparia 3 sp.
Solenopleura.
Neolenus inflatus Walcott.
Neolenus intermedius Walcott.
Neolenus intermedius pugio Walcott.
Neolenus superbus Walcott.

30h. (For stratigraphic position and association, see p. 154.) Upper Cambrian: About 350 feet (106.7 m.) above the Middle Cambrian and 2,950 feet (899.2 m.) below the top of the Upper Cambrian, near the base of the arenaceous limestones forming 2a of the Orr formation [Walcott, 1908f, p. 177], on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (F. B. Weeks, 1905).

Lingulella desiderata.
Acrotreta idahoensis.
Acrotreta idahoensis sulcata.
Crepicephalus texanus (Shumard).
Bathyuriscus.
Illænurus?.

30j. (For stratigraphic position and association, see p. 154.) Upper Cambrian: About 950 feet (289.6 m.) above the Middle Cambrian and 2,450 feet (746.8 m.) below the top of the Upper Cambrian, near the base of the arenaceous shales and limestones forming 1e of the Orr formation [Walcott, 1908f, p. 176], on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1905).

Micromitra (Paterina) crenistria.
Obolus mcconnelli pelias.
Lingulella desiderata.
Lingulella isse.
*Linnarssonella transversa.
Agnostus.
Crepicephalus.

30k (25 feet below 31t at same locality). (For stratigraphic position and association, see p. 154.) Upper Cambrian: 1,150 feet (350.5 m.) above the Middle Cambrian and 2,175 feet (662.9 m.) below the top of the Upper Cambrian, at the top of the arenaceous shales and limestones forming 1e of the Orr formation [Walcott, 1908f, p. 176], on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1905).

Lingulella desiderata.
Lingulella isse.
*Linnarssonella modesta.
Ptychoparia?.
Solenopleura.

30l (30y is the metamorphosed equivalent of this at different locality). (For stratigraphic position and association, see p. 153.) Upper Cambrian: About 1,400 feet (426.7 m.) above the Middle Cambrian and 1,900 feet (579.1 m.) below the top of the Upper Cambrian, in the shales forming 1b of the Orr formation [Walcott, 1908f, p. 176], on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass [Walcott, 1908f, Pl. XIII], House Range, Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1905).

Lingulella manticula.
Section of crinoid column.
Ptychaspis.
Anomocare.

30m. (For stratigraphic position and association, see p. 153.) Upper Cambrian: About 1,950 feet (584.4 m.) above the Middle Cambrian and 1,350 feet (411.5 m.) below the top of the Upper Cambrian, in the siliceous limestones forming 1e of the Notch Peak limestone [Walcott, 1908f, p. 175], on the slopes of Notch Peak, about 5 miles (8 km.) southwest of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1905).

*Obolus tetonensis leda.

30n (=30n′). (For stratigraphic position and association, see p. 155.) Middle Cambrian: About 3,750 feet (1,143 m.) above the Lower Cambrian and 650 feet (198 m.) below the Upper Cambrian, in the shaly limestones forming 1c of the Weeks limestone [Walcott, 1908f, p. 175], on the north side of Weeks Canyon, about 4 miles (6.4 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (C. D. Walcott and L. D. Burling, 1905).

*Obolus (Fordinia) perfectus.
Lingulella isse.
Acrotreta ophirensis.
*Acrotreta ophirensis descendens.
Hyolithes.
Agnostus, several species.
Ptychoparia, several species.
Asaphiscus sp.
Crepicephalus texanus (Shumard).
Neolenus.
Solenopleura.

30n′ (=30n, but in slightly higher beds). (For stratigraphic position and association, see p. 155.) (C. D. Walcott and L. D. Burling, 1905.)

30o (=14v). (For stratigraphic position and association, see p. 154.) Middle Cambrian: About 3,950 feet (1,204 m.) above the Lower Cambrian and 450 feet (137.2 m.) below the Upper Cambrian, in the shaly limestones forming 1b of the Weeks limestone [Walcott, 1908f, p. 178], on the north side of Weeks Canyon, about 4 miles (6.4 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (C. D. Walcott and L. D. Burling, 1905).

Obolus (Fordinia) perfectus.
Asaphiscus sp.
Agnostus, several species.
Ptychoparia.
Crepicephalus texanus (Shumard).
Bathyuriscus.
Anomocare?.
Solenopleura.

30p. (For stratigraphic position and association, see p. 151.) Middle Cambrian: About 125 feet (38 m.) above the Cambrian quartzitic sandstones on the north side of Ogden Canyon, about 1 mile (1.6 km.) above its mouth, east of Ogden, Weber County, Utah (F. B. Weeks and L. D. Burling, 1905).

Micromitra (Paterina) labradorica utahensis.
Obolus mcconnelli.
Obolus (Westonia) ella.

30q. (For stratigraphic position and association, see p. 149.) Upper Cambrian: Limestones about 2,300 feet (701 m.) above the Cambrian quartzitic sandstones on pipe line above limekiln in Ogden Canyon, 1 mile (1.6 km.) above its mouth, east of Ogden, Weber County, Utah (F. B. Weeks and L. D. Burling, 1905).

Obolus rotundatus.
Lingulella manticula.

30s. (For stratigraphic position and association, see p. 149.) Upper Cambrian: Green shale about 1,200 feet (365.8 m.) above the Cambrian quartzitic sandstones on pipe line above limekiln in Ogden Canyon, 1 mile (1.6 km.) above its mouth, east of Ogden, Weber County, Utah (L. D. Burling, 1905).

Lingulella isse.

30u. (For stratigraphic position and association, see p. 151.) Middle Cambrian: Sandy shales about 250 feet (76.2 m.) above the top of the Cambrian quartzitic sandstones 4 miles (6.4 km.) northwest of Promontory Point station (on the "Lucin cut-off" of the Union Pacific Railway), about halfway up west end of ridge, north of Great Salt Lake, Boxelder County, Utah (F. B. Weeks, 1905).

Micromitra (Paterina) labradorica utahensis.
Acrotreta cf. ophirensis.

30w. (For stratigraphic position and association, see p. 153.) Upper Cambrian: Drift bowlder of limestone supposed to have come from the beds forming 1a of the Notch Peak limestone on Notch Peak [Walcott, 1908f, p. 175], found about 2 miles (3.2 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (C. D. Walcott and F. B. Weeks, 1905).

Schizambon typicalis.
Eoorthis desmopleura.
Agraulos.
Solenopleura.
Illænurus.

30y (the metamorphosed equivalent of 30l at a different locality). (For stratigraphic position and association, see p. 153.) Upper Cambrian: About 1,400 feet (426.7 m.) above the Middle Cambrian and 1,900 feet (579.1 m.) below the top of the Upper Cambrian, in the supposed metamorphosed equivalent of the shales forming 1b of the Orr formation [Walcott, 1908f, p. 176], above the granite contact on top of the ridge north of Notch Peak [Walcott, 1908f, Pls. XIII and XIV], House Range, Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1905).

Obolus rotundatus.
Lingulella isse.
Anomocare.

30z. (For stratigraphic position and association, see p. 156.) Middle Cambrian: About 2,450 feet (746.8 m.) above the Lower Cambrian and 1,950 feet (594.4 m.) below the Upper Cambrian, in the upper part of the limestone forming 1c of the Marjum limestone [Walcott, 1908f, p. 180], in the long cliff about 2 miles (3.2 km.) southeast of Marjum Pass, House Range [Walcott, 1908f, Pls. XIII and XV], Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1905).

Acrotreta pyxidicula.
Agnostus.
Ptychoparia.

31. (For stratigraphic position and association, see p. 158.) Middle Cambrian: Shales at the Chisholm mine, southwest slope of Ely Mountains, 3 miles (4.8 km.) northwest of Pioche, Lincoln County, Nev. (C. D. Walcott and J. E. W., 1885).

Micromitra (Iphidella) pannula.
Obolus (Westonia) ella.
*Lingulella dubia.
Eocystites longidactylus Walcott.
Hyolithes billingsi Walcott.
Zacanthoides typicalis (Walcott).
Ptychoparia piochensis Walcott.
Anomocare parvum Walcott.
Bathyuriscus howelli Walcott.
Bathyuriscus productus (Hall and Whitfield).

31a. (For stratigraphic position and association, see p. 158.) Lower Cambrian: Limestone and interbedded siliceous shales of the Pioche formation [Walcott, 1908a, p. 11], just above the quartzite on the east side of the anticline, near Pioche, Lincoln County, Nev. (C. D. Walcott and J. E. W., 1885).

*Micromitra (Iphidella) pannula.
*Acrothele spurri.
*Acrothele subsidua hera.
*Acrotreta primæva.
*Billingsella highlandensis.
Hyolithes billingsi Walcott.
Bellerophon antiquatus Whitfield.
*Olenellus gilberti (Meek).
Olenoides sp.
Oryctocephalus primus Walcott.
Zacanthoides levis (Walcott).
Crepicephalus augusta Walcott.
Crepicephalus liliana Walcott.
Ptychoparia sp.

31c (=54o; same horizon as 32e). (For stratigraphic position and association, see p. 151.) Middle Cambrian: About 900 feet (274.3 m.) above the Brigham quartzite and 3,300 feet (1,006.5 m.) below the Upper Cambrian, in the limestone forming 1h of the Ute limestone [Walcott, 1908f, p. 196], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (L. D. Burling, 1905).

Obolus mcconnelli.
Acrotreta cf. ophirensis.
Acrotreta sp. undt.
Otusia utahensis.
Eoorthis zeno.
Syntrophia cambria.
Zacanthoides.
Ptychoparia subcoronata (Hall and Whitfield).
Dorypyge? quadriceps (Hall and Whitfield).

31d (=54l). (For stratigraphic position and association, see p. 152.) Middle Cambrian: About 500 feet (152.4 m.) above the Brigham quartzite and 3,700 feet (1,127.8 m.) below the Upper Cambrian, in the Spence shale member of the Ute limestone [Walcott, 1908f, p. 197], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (F. B. Weeks, 1905).

Obolus (Westonia) ella?.
Ptychoparia.

31e (=54a). (For stratigraphic position and association, see p. 151.) Middle Cambrian: About 750 feet (228.6 m.) above the Brigham quartzite and 3,440 feet (1,048.5 m.) below the Upper Cambrian, in the shales forming 2a of the Ute limestone [Walcott, 1908f, p. 196], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (L. D. Burling, 1905).

Obolus (Westonia) ella.
Ptychoparia.

31h (=55n). (For stratigraphic position and association, see p. 150.) (F. B. Weeks, 1905.)

31l (=54h). (For stratigraphic position and association, see p. 149.) Middle Cambrian: About 3,140 feet (957.1 m.) above the Brigham quartzite and 1,050 feet (320 m.) below the Upper Cambrian, in the limestones forming 1a of the Bloomington formation [Walcott, 1908f, p. 194], in Blacksmith Fork Canyon, about 9 miles (14.4 km.) east of Hyrum, Cache County, Utah (L. D. Burling, 1905).

Lingulella desiderata.
Agnostus.

31m (=55h). (For stratigraphic position and association, see p. 149). Upper Cambrian: About 175 feet (53.3 m.) above the Middle Cambrian and 1,050 feet (320 m.) below the top of the Upper Cambrian, near the base of the limestones forming 3 of the St. Charles limestone [Walcott, 1908f, p. 192], in Blacksmith Fork Canyon, about 9 miles (14.4 km.) east of Hyrum, Cache County, Utah (L. D. Burling, 1905).

Obolus sp. undt.
Lingulella manticula.
Billingsella coloradoensis.
Agnostus.
Ptychoparia.

31n (=55g). (For stratigraphic position and association, see p. 149.) Upper Cambrian: About 250 feet (76.2 m.) above the Middle Cambrian and 975 feet (297.2 m.) below the top of the Upper Cambrian, in the upper part of the limestone forming 3 of the St. Charles limestone [Walcott, 1908f, p. 192], in Blacksmith Fork Canyon, about 9 miles (14.4 km.) east of Hyrum, Cache County, Utah (L. D. Burling, 1905).

Acrotreta? sp.
Anomocare.

31q. (For stratigraphic position and association, see p. 153.) Upper Cambrian: About 2,800 feet (853.4 m.) above the Middle Cambrian and 500 (152.4 m.) below the top of the Upper Cambrian, in the gray limestone forming 1a of the Notch Peak limestone [Walcott, 1908f, p. 175], north slope of Notch Peak, House Range [Walcott, 1908f, Pls. XIII and XIV], Millard County, Utah (F. B. Weeks, 1905).

Lingulella isse.
Dikellocephalus?.

31s. (For stratigraphic position and association, see p. 157.) Middle Cambrian: 490 feet (149.4 m.) above the Lower Cambrian and 3,925 feet (1,196.3 m.) below the Upper Cambrian, in the pinkish argillaceous shale forming 1d of the Howell formation [Walcott, 1908f, p. 182], south side of Dome Canyon, about 1 mile (1.6 km.) below the divide and 3 miles (4.8 km.) west-southwest of Antelope Springs, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (C. D. Walcott and F. B. Weeks, 1905).

Micromitra (Iphidella) pannula.
Obolus (Westonia) ella.
Acrothele spurri.
Acrotreta cf. ophirensis.
Scenella.
Hyolithes.
Zacanthoides.
Bathyuriscus.

31t (25 feet above 30k at same locality). (For stratigraphic position and association, see p. 154.) Upper Cambrian: About 1,175 feet (358.1 m.) above the Middle Cambrian and 2,150 feet (655.3 m.) below the top of the Upper Cambrian, in the limestone forming 1d of the Orr formation [Walcott, 1908f, p. 176], on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah (L. D. Burling, 1905).

Linnarssonella modesta.
*Linnarssonella nitens.
Solenopleura.
Protaspis.

31u. (For stratigraphic position and association, see p. 158.) Middle Cambrian: Shales on west slope of spur facing the main part of the Highland Range, 3 miles (4.8 km.) northwest of Pioche, Lincoln County, Nev.

Walcott [1891b, p. 318] cites the following species from this locality:

Lingulella ella=Obolus (Westonia) ella.
Kutorgina pannula=Micromitra (Iphidella) pannula.
Eocystites?? longidactylus Walcott.
Hyolithes billingsi Walcott.
Ptychoparia piochensis Walcott.
Zacanthoides typicalis (Walcott).
Bathyuriscus howelli Walcott.
Bathyuriscus productus (Hall and Whitfield).

31v. (For stratigraphic position and association, see p. 157.) Middle Cambrian: 650 feet (198.1 m.) above the Lower Cambrian and 3,750 feet (1,143 m.) below the Upper Cambrian, in shales at the top of the limestone forming 1a of the Howell formation [Walcott, 1908f, p. 182], northeast side of Dome Canyon, about 4 miles (6.4 km.) west-southwest of Antelope Springs, House Range [Walcott, 1908f, Pls. XIII and XVI], Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1905).

Micromitra (Iphidella) pannula.
Acrotreta cf. ophirensis.
Ptychoparia.

31y. (For stratigraphic position and association, see p. 151.) Middle Cambrian: Thin-bedded limestone about 125 feet (38 m.) above the Cambrian quartzitic sandstones in the Wasatch Mountains, 1 mile (1.6 km.) northwest of Geneva (Copenhagen), east of Brigham, Boxelder County, Utah (F. B. Weeks and L. D. Burling, 1905).

Obolus mcconnelli.
Lingulella isse.

31z (=55t). (For stratigraphic position and association, see p. 151.) Middle Cambrian: About 350 feet (106.7 m.) above the Brigham quartzite, in the limestone of the Ute limestone [Walcott, 1908a, p. 7], on west side of road, 0.5 mile (0.8 km.) above the forks, Paradise Dry Canyon (locally known as East Fork), east of Paradise, Cache County, Utah (F. B. Weeks, 1905).

Otusia utahensis.
Acrotreta ophirensis.

32. Lower Cambrian: Sandstone on the south slope of Stissing Mountain, Dutchess County, N. Y. (C. D. Walcott, 1886).

*Obolella minor.
Obolella sp.
Elliptocephala asaphoides Emmons.

32a. Lower Cambrian: Limestone, 0.75 mile (1.2 km.) west of Riders Mill station on the Harlem Extension Railroad, about 9 miles (14.4 km.) north-northeast of Chatham, Kinderhook quadrangle (U. S. G. S.), Columbia County, N. Y. (C. D. Walcott and T. N. Dale, 1891).

Bicia gemma.
Acrotreta sagittalis taconica.

32c. (For stratigraphic position and association, see p. 152.) Middle Cambrian: About 60 feet (18.3 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], in green shale 1 mile (1.6 km.) northwest of Geneva (Copenhagen), east of Brigham, Boxelder County, Utah (L. D. Burling, 1905).

Acrotreta cf. ophirensis.

32d. (For stratigraphic position and association, see p. 152.) Middle Cambrian: Shales about 150 feet (45.7 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], on the east side of the south fork of Paradise Dry Canyon (locally known as East Fork), east of Paradise, Cache County, Utah (F. B. Weeks, 1905).

Micromitra (Paterina) labradorica utahensis.
Obolus (Westonia) ella.

32e (same horizon as 31c and 54o). (For stratigraphic position and association, see p. 151.) Middle Cambrian: About 900 feet (274.3 m.) above the Brigham quartzite and 3,300 feet (1,005.8 m.) below the Upper Cambrian, in limestone corresponding to that forming 1b of the Ute limestone [Walcott, 1908f, p. 196], just south of the south fork of Paradise Dry Canyon (locally known as East Fork), east of Paradise, Cache County, Utah (L. D. Burling, 1905).

Otusia utahensis.
*Syntrophia cambria.

32f. (For stratigraphic position and association, see p. 153.) Upper Cambrian: Thin-bedded siliceous limestone near the top of the Upper Cambrian, about 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range, Tooele County, Utah (F. B. Weeks and L. D. Burling, 1905).

Lingulella manticula.
Lingulella pogonipensis.

32g. (For stratigraphic position and association, see p. 154.) Upper Cambrian: About 2,575 feet (784.9 m.) above the Cambrian quartzitic sandstones, in a blue limestone about 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range, Tooele County, Utah (L. D. Burling, 1905).

Obolus mcconnelli pelias.
Lingulella desiderata.
Lingulella isse.
Linnarssonella nitens.

32h. (For stratigraphic position and association, see p. 157.) Middle Cambrian: Shales in a canyon on the west side of the Simpson Range, 4 miles (6.4 km.) south of Simpson Spring, about 20 miles (32.2 km.) west-southwest of Vernon, Tooele County, Utah (F. B. Weeks and L. D. Burling, 1905).

Obolus (Westonia) ella.

32j. (For stratigraphic position and association, see p. 157.) Middle Cambrian: 625 feet (190.5 m.) above the Cambrian quartzitic sandstones, in pinkish-colored very fine grained arenaceous shale 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range, Tooele County, Utah (L. D. Burling, 1905).

Acrotreta cf. ophirensis.

32k. (For stratigraphic position and association, see p. 156.) Middle? Cambrian: Limestones about 1,550 feet (472.4 m.) above the top of the Cambrian quartzitic sandstones 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range, Tooele County, Utah (L. D. Burling, 1905).

Obolus mcconnelli.

32n. (For stratigraphic position and association, see p. 151.) Middle Cambrian: Shales about 725 feet (221 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], in the Wasatch Mountains, 1 mile (1.6 km.) northwest of Geneva (Copenhagen), Boxelder County, Utah (L. D. Burling, 1905).

Obolus (Westonia) ella?.

32o. (For stratigraphic position and association, see p. 158.) Middle Cambrian: Shale about 325 feet (99 m.) above the Cambrian quartzitic sandstones 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range, Tooele County, Utah (L. D. Burling, 1905).

Obolus (Westonia) ella.

32p (=55e). (For stratigraphic position and association, see p. 152.) (L. D. Burling, 1905.)

Obolus (Westonia) ella.
Acrothele subsidua.

32t. (For stratigraphic position and association, see p. 154.) Upper Cambrian: Limestone about 3,650 feet (1,112.5 m.) above the Cambrian quartzitic sandstones in Fandango Spring canyon, on the east side of the Dugway Range, about 5 miles (8 km.) north of where the stage road between Vernon and Deep Creek crosses the divide, Tooele County, Utah (L. D. Burling, 1905).

Linnarssonella girtyi.

32x (=54k faunally). (For stratigraphic position and association, see p. 150.) Middle Cambrian: About 1,700 feet (518.2 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], in shales correlated with the shales forming 2d of the Bloomington formation in Blacksmith Fork Canyon [Walcott, 1908f, p. 195], Wasatch Canyon, east of Lakeview ranch, 5 miles (8 km.) north of Brigham, Boxelder County, Utah (L. D. Burling, 1905).

Obolus (Westonia) wasatchensis.

32y. (For stratigraphic position and association, see p. 151.) Middle Cambrian: Shales about 175 feet (53.3 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], in the Wasatch Mountains, 1 mile (1.6 km.) northwest of Geneva (Copenhagen), east of Brigham, Boxelder County, Utah (F. B. Weeks and L. D. Burling, 1905).

Obolus (Westonia) ella.

32z (below 32h at same locality). (For stratigraphic position and association, see p. 157.) Middle Cambrian: Shales in a canyon on the west side of the Simpson Range, 4 miles (6.4 km.) south of Simpson Spring, about 20 miles (32.2 km.) west-southwest of Vernon, Tooele County, Utah (F. B. Weeks and L. D. Burling, 1905).

Obolus (Westonia) ella.

33 (see 338c). Lower Cambrian: Limestone on the roadside near Rock Hill schoolhouse, near North Greenwich, about 5 miles (8 km.) north-northeast of Greenwich, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1886).

Botsfordia cælata.
Acrotreta sagittalis taconica.
Billingsella salemensis.
Archæocyathus dwighti Walcott.
Hyolithellus micans (Billings).
Hyolithes americanus Billings.
Hyolithes communis Billings.
Hyolithes impar Ford.
Stenotheca elongata Walcott.
Stenotheca rugosa (Hall).
Microdiscus lobatus (Hall).
Microdiscus speciosus Ford.
Elliptocephala asaphoides Emmons.
Zacanthoides eatoni Walcott.
Ptychoparia cf. adamsi (Billings).
Protypus clavatus Walcott.
Solenopleura tumida Walcott.

33b. Lower Cambrian: Limestone, 1.5 miles (2.4 km.) east-southeast of North Greenwich, about 5 miles (8 km.) north-northeast of Greenwich, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1886).

Botsfordia cælata.
Hyolithellus micans (Billings).
Hyolithes communis Billings.
Microdiscus lobatus (Hall).
Microdiscus speciosus Ford.
Elliptocephala asaphoides Emmons.

33d (same horizon as 15d). (For stratigraphic position and association, see p. 154.) Upper Cambrian: Thin-bedded blue limestone at the base of the first high point southwest of the J. J. Thomas ranch, on the east side of the Fish Spring Range, Juab County, Utah (L. D. Burling, 1905).

Obolus mcconnelli pelias.
Obolus rotundatus.
Lingulella isse.
Schizambon typicalis.
Acrotreta marjumensis.

33f. (For stratigraphic position and association, see p. 157.) Middle Cambrian: Shales about 400 feet (122 m.) above the Cambrian quartzitic sandstones on the western slope of the high peak southwest of Lookout Pass, Onaqui Range, west of Vernon, Tooele County, Utah (L. D. Burling, 1905).

*Obolus (Westonia) ella onaquiensis.
Obolus (Westonia) cf. ella onaquiensis.

33i. (For stratigraphic position and association, see p. 158.) Lower Cambrian: About 100 feet (30.5 m.) above the Prospect Mountain quartzite, in the shale of the Pioche formation [Walcott, 1908f, p. 171], 0.25 mile (0.4 km.) below the Maxfield mine, Big Cottonwood Canyon, west front of the Wasatch Mountains southeast of Salt Lake City, Salt Lake County, Utah (L. D. Burling, 1905).

Obolus (Westonia) ella.

33j. (For stratigraphic position and association, see p. 149.) Middle Cambrian: Shale about 2,300 feet (701 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], in Wasatch Canyon, east of Lakeview ranch, 5 miles (8 km.) north of Brigham, Boxelder County, Utah (L. D. Burling, 1905).

Obolus (Westonia) wasatchensis.

33l. (For stratigraphic position and association, see p. 153.) Upper Cambrian: Limestones in pass between the Pavant Mountains and the Canyon Range, a few hundred yards east of the divide, on the road between Holden and Scipio, Millard County, Utah (L. D. Burling, 1905).

Eoorthis desmopleura.
Solenopleura.
Illænurus.

33n. (For stratigraphic position and association, see p. 154.) Middle? Cambrian: Limestone pebbles, west front of the Pavant Mountains, collected in the wash at the mouth of Crow Creek, about 4 miles (6.4 km.) east of Fillmore, Millard County, Utah (L. D. Burling, 1905).

Acrotreta idahoensis alta.

33r. (For stratigraphic position and association, see p. 157.) Middle Cambrian: Limestones faulted against the Cambrian quartzites in a canyon about 1 mile (1.6 km.) east of Cricket Spring, Cricket Range (locally known as the Beaver River Range or the Beaver Mountains), northwest of Black Rock, Millard County, Utah (L. D. Burling, 1905).

*Otusia utahensis.

33t. (For stratigraphic position and association, see p. 150.) Middle Cambrian: Shale about 1,500 feet (457.2 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], 1 mile (1.6 km.) northwest of Geneva (Copenhagen), east of Brigham, Boxelder County, Utah (F. B. Weeks, 1905).

Obolus (Westonia) wasatchensis.

34. Lower Cambrian: Limestone on roadside a little west of the bridge over Poultney River at Low Hampton, about 5 miles (8 km.) east-northeast of Whitehall, Whitehall quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1886).

Micromitra (Iphidella) pannula.
Lingulella granvillensis.
Botsfordia cælata.
Acrotreta sagittalis taconica.
Platyceras primævum Billings.
Hyolithes communis Billings.
Microdiscus connexus Walcott.
Microdiscus lobatus (Hall).
Microdiscus speciosus Ford.
Elliptocephala asaphoides Emmons.
Ptychoparia cf. adamsi (Billings).
Ptychoparia fitchi Walcott.
Solenopleura tumida Walcott.
Zacanthoides eatoni Walcott.

34a. Lower Cambrian: Limestones 1 mile (1.6 km.) west of North Hebron, 5 miles (8 km.) south-southwest of Granville, Fort Ann quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1886).

Botsfordia cælata.
Microdiscus lobatus (Hall).
Microdiscus speciosus Ford.

34g. (For stratigraphic position and association, see p. 153.) Passage beds between the Cambrian and Ordovician: Limestones about 1,000 feet (305 m.) above the valley on the east side of the Fish Spring Range, just west of the high point southwest of the J. J. Thomas ranch, Juab County, Utah (L. D. Burling, 1905).

Eoorthis desmopleura.

34i. (For stratigraphic position and association, see p. 154.) Upper Cambrian: Shales about 1 mile (1.6 km.) northeast of Sand Pass, at the south end of the Fish Spring Range, Juab County, Utah (C. D. Walcott and L. D. Burling, 1905).

Obolus rotundatus.
Lingulella desiderata.
Lingulella isse.

34m. (For stratigraphic position and association, see p. 151.) Middle Cambrian: Limestone about 765 feet (233.2 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], 1 mile (1.6 km.) northwest of Geneva (Copenhagen), east of Brigham, Boxelder County, Utah (L. D. Burling, 1905).

Micromitra (Paterina) labradorica utahensis.
Syntrophia cambria.

34n. (For stratigraphic position and association, see p. 158.) Middle Cambrian: Shales about 100 feet (30.5 m.) above the Tintic quartzite [G. O. Smith, 1900, p. 1], near the summit of the ridge between Mammoth and Eureka, Tintic special quadrangle (U. S. G. S.), Juab County, Utah (F. B. Weeks, 1905).

Obolus mcconnelli.
Obolus rotundatus.

34q. (For stratigraphic position and association, see p. 149.) Upper Cambrian: Shales about 3,800 feet (1,158.2 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], in Wasatch Canyon, east of Lakeview Ranch, about 5 miles (8 km.) north of Brigham, Boxelder County, Utah (L. D. Burling, 1905).

Obolus mcconnelli pelias.
Acrotreta idahoensis alta.

34r. (For stratigraphic position and association, see p. 154.) Upper Cambrian: Limestones 1.5 miles (2.4 km.) northwest of Wahwah Spring, about halfway up the section to the north of the road at Cane Pass, Wahwah Mountains, Beaver County, Utah (F. B. Weeks, 1905).

Obolus rotundatus.
Lingulella isse.

34s. (For stratigraphic position and association, see p. 156.) Middle Cambrian: About 1,700 feet (518 m.) above the Tintic quartzite, in the Mammoth limestone of G. O. Smith [1900, p. 1, and historical geology sheet], in the saddle above and a little east of the Centennial Eureka mine, near the summit of the ridge between Mammoth and Eureka, Tintic special quadrangle (U. S. G. S.), Juab County, Utah (F. B. Weeks, 1905).

Obolus mcconnelli.

34t. (For stratigraphic position and association, see p. 154.) Upper Cambrian: Limestone 1.5 miles (2.4 km.) northwest of Wahwah Springs, about 80 feet (24.4 m.) below the highest point on the north side of the road at Cane Pass, Wahwah Mountains, Beaver County, Utah (F. B. Weeks, 1905).

Lingulella desiderata.
Lingulella isse.

34u. (For stratigraphic position and association, see p. 157.) Middle Cambrian: Shales about 950 feet (289.6 m.) above the Cambrian quartzitic sandstones 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range, Tooele County, Utah (L. D. Burling, 1905).

Obolus (Westonia) wasatchensis.

34v. (For stratigraphic position and association, see p. 155.) Middle? Cambrian: Limestone about 1,750 feet (533 m.) above the Cambrian quartzitic sandstones about 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range, Tooele County, Utah (L. D. Burling, 1905).

Obolus mcconnelli pelias.

35. Lower Cambrian: Limestones 1.5 miles (2.4 km.) north of Bald Mountain and 3.5 miles (5.6 km.) north-northwest of Greenwich, Schuylerville quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1886).

Obolus prindlei.
Lingulella granvillensis.
Obolella crassa.
Botsfordia cælata.
Acrotreta sagittalis taconica.
Stenotheca rugosa (Hall).
Platyceras primævum Billings.
Hyolithellus micans (Billings).
Hyolithellus micans rugosa Walcott.
Hyolithes communis Billings.
Elliptocephala asaphoides Emmons.
Solenopleura tumida Walcott.

35a. Lower Cambrian: Shaly limestone on the west slope of the summit of Bald Mountain, 3 miles (4.8 km.) north-northwest of Greenwich, Schuylerville quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1886).

Botsfordia cælata.
*Acrotreta emmonsi.
Olenellus sp.

35c. (For stratigraphic position and association, see p. 130.) Lower Cambrian: Drift blocks of siliceous shale supposed to have come from the Mount Whyte formation [Walcott, 1908f, p. 214], found on the south slope of Mount Bosworth, about 500 feet (152 m.) northwest of the Canadian Pacific Railway track between Stephen and Hector, eastern British Columbia, Canada (Mr. and Mrs. C. D. Walcott and Mr. and Mrs. L. D. Burling, 1907).

*Micromitra (Paterina) wapta.
*Obolus parvus.
Acrothele colleni.
Wimanella simplex.
Hyolithellus.
Hyolithes.
*Albertella bosworthi Walcott.
*Albertella helena Walcott.
Bathyuriscus.
Agraulos.
Ptychoparia.
Bathyuriscus.

35d. (For stratigraphic position and association, see p. 130.) Lower Cambrian: About 3,150 feet (960.1 m.) below the Middle Cambrian, in the siliceous Lake Louise shale [Walcott, 1908f, p. 216], in cliff on the north side of Lake Louise, at its upper end, southeast of Laggan, on the Canadian Pacific Railway, Alberta, Canada (Mr. and Mrs. C. D. Walcott and Mr. and Mrs. L. D. Burling, 1907).

*Micromitra (Iphidella) louise.
Cruziana.
Annelid trails.

35e. (For stratigraphic position and association, see p. 130.) Lower Cambrian: About 270 feet (82.3 m.) below the Middle Cambrian, in a greenish siliceous shale correlated with No. 3 of the Mount Whyte formation on Mount Bosworth [Walcott, 1908f, p. 214], in the amphitheater between Popes Peak and Mount Whyte, about 3 miles (4.8 km.) northwest of Lake Louise, southwest of Laggan on the Canadian Pacific Railway, Alberta, Canada (C. D. Walcott and L. D. Burling, 1907).

Micromitra (Paterina) wapta.
Obolus parvus.
Acrothele colleni.
Hyolithes billingsi Walcott.
Olenopsis.
Ptychoparia sp.
Albertella sp.
Bathyuriscus.
Olenellus gilberti (Meek).

35f. (For stratigraphic position and association, see p. 130.) Lower Cambrian: About 300 feet (91 m.) below the Middle Cambrian, in the limestone forming 6 of the Mount Whyte formation [Walcott, 1908c, p. 242 (11)], just above the tunnel on the north shoulder of Mount Stephen, about 3 miles (4.8 km.) east of Field, British Columbia, Canada (C. D. Walcott and L. D. Burling, 1907).

Micromitra (Iphidella) pannula var.
Kutorgina cingulata.
Kutorgina?.
Acrotreta sagittalis taconica.
Nisusia festinata.
Hyolithes billingsi Walcott.
Scenella varians Walcott.
Ptychoparia 3 sp.
Agraulos sp.
Protypus sp.
Olenellus canadensis Walcott.
Olenellus gilberti (Meek).

35g. (For stratigraphic position and association, see p. 126.) Middle Cambrian: About 4,100 feet (1,250 m.) above the Lower Cambrian and 860 feet (262 m.) below the Upper Cambrian, in the shaly limestones in 2 of the Eldon limestone [Walcott, 1908f, p. 209], at the north end of the amphitheater northwest of the main ridge of Mount Bosworth, north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide between British Columbia and Alberta, Canada (C. D. Walcott and L. D. Burling, 1907).

Obolus mcconnelli var.
*Obolus membranaceus.
Isoxys cf. argentea (Walcott).
Ptychoparia 3 sp.

35h. (For stratigraphic position and association, see p. 130.) Lower Cambrian: About 375 feet (114 m.) below the Middle Cambrian, in the shales of No. 4 of the Mount Whyte formation [Walcott, 1908f, p. 214], on Mount Bosworth, north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide between British Columbia and Alberta, Canada (Mr. and Mrs. C. D. Walcott, Mr. and Mrs. L. D. Burling, and Helen and Stuart Walcott).

Nisusia festinata.
Scenella varians Walcott.
Hyolithellus.
Ptychoparia.
Agraulos.
Olenellus canadensis Walcott.
Olenellus gilberti (Meek).

35k. (For stratigraphic position and association, see p. 127.) Middle Cambrian: Burgess shale member of the Stephen formation on the west slope of the ridge between Mount Field and Wapta Peak, 1 mile (1.6 km.) northeast of Burgess Pass, above Field, British Columbia (Mr. and Mrs. C. D. Walcott and Stuart Walcott, 1909 and 1910.)[a]

*Micromitra zenobia.
*Micromitra (Paterina) stissingensis ora.
Micromitra (Iphidella) pannula.
Nisusia alberta.

36 (see 338d). Lower Cambrian: Limestone 1 mile (1.6 km.) south of Shushan and 3.5 miles (5.6 km.) northnortheast of Cambridge, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1886).

Acrotreta sagittalis taconica.
Nisusia festinata.
* Billingsella salemensis.
Hyolithellus micans (Billings).
Hyolithes communis Billings.
Microdiscus speciosus Ford.
Elliptocephala asaphoides Emmons.
Solenopleura tumida Walcott.

36b. Lower Cambrian: Limestone near schoolhouse No. 12, near Greenwich, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y. (O. C. Tefft, 1887).

Obolus prindlei.
Botsfordia cælata.
Acrotreta sagittalis taconica.
Hyolithellus micans (Billings).
Microdiscus lobatus (Hall).
Microdiscus sp.

37. Lower Cambrian: Limestone 1.5 miles (2.4 km.) south of Salem, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1886).

Billingsella salemensis.

37b. Lower Cambrian: Limestone 0.25 mile (0.4 km.) east of Salem, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1893).

Lingulella granvillensis.
*Yorkia washingtonensis.
Acrotreta sagittalis taconica.
Olenellus?.
Microdiscus connexus Walcott.

38. Lower Cambrian: Limestone 0.25 mile (0.4 km.) north of John Hulett's farmhouse, about 3 miles (4.8 km.) west of South Granville, and 4.5 miles (7.2 km.) southwest of Granville, Fort Ann quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1886).

Lingulella granvillensis.
Botsfordia cælata.
Stenotheca elongata Walcott.
Hyolithes impar Ford.
Elliptocephala asaphoides Emmons.

[a] This is the locality containing the beautifully preserved annelids, medusæ, eurypterids, holothurians, crustaceans, etc., now being described and illustrated in volume 57 of the Smithsonian Miscellaneous Collections.

38a. Lower Cambrian: Limestone 2 miles (3.2 km.) south of North Granville, on the road which turns south from the road running between that village and Truthville, 4 miles (6.4 km.) west-northwest of Granville, Fort Ann quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1886).

Micromitra (Iphidella) pannula.
Obolus prindlei.
*Lingulella granvillensis.
Lingulella sp.
Botsfordia cælata.
Yorkia? washingtonensis.
Acrotreta emmonsi.
*Acrotreta sagittalis taconica
Nisusia festinata.
Protospongia sp.
Platyceras primævum Billings
Hyolithellus micans (Billings).
Hyolithellus micans rugosa Walcott.
Hyolithes americanus Billings
Hyolithes impar Ford.
Agnostus sp.
Microdiscus connexus Walcott.
Microdiscus lobatus (Hall).
Microdiscus speciosus Ford.
Elliptocephala asaphoides Emmons.
Ptychoparia cf. adamsi (Billings).
Ptychoparia fitchi Walcott.
Ptychoparia sp.
Protypus clavatus Walcott.
Zacanthoides eatoni Walcott.
Olenoides fordi Walcott.

38c. Lower Cambrian: Shale at the slate quarries on the west side of the valley 1 mile (1.6 km.) north of Middle Granville, Mettawee quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1886).

Botsfordia cælata.

39. Lower Cambrian: Limestone south of the Delaware and Hudson Railroad track, on the road running south-southwest from Low Hampton, about 5 miles (8 km.) east-northeast of Whitehall, Whitehall quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1886).

Botsfordia cælata.
Acrotreta sagittalis taconica.
Archæocyathus dwighti Walcott.
Microdiscus speciosus Ford.
Protypus clavatus Walcott.

39a. Lower Cambrian: Limestone 0.25 mile (0.4 km.) north of Easton Station, 3 miles (4.8 km.) south of Greenwich, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1887).

Botsfordia cælata.
Hyolithellus micans rugosa Walcott.
Microdiscus lobatus (Hall).

41 (same horizon as 51). (For stratigraphic position and association, see p. 141.) Lower Cambrian: Sandstone [see Walcott, 1891b, p. 260, for position in section] on Manuels Brook, Conception Bay, Newfoundland (C. D. Walcott, 1888).

*Obolella atlantica.
Hyolithellus micans (Billings).
Helenia bella Walcott.
Hyolithes princeps Billings.
Hyolithes quadricostatus Shaler and Foerste.
Hyolithes similis Walcott.
Hyolithes sp.
Stenotheca rugosa (Hall).
Stenotheca rugosa acuticosta Walcott.
Stenotheca rugosa erecta Walcott.
Stenotheca rogosa lævis Walcott.
Stenotheca rugosa pauper Billings.
Coleoloides typicalis Walcott.
Microdiscus bellimarginatus Shaler and Foerste.
Microdiscus helena Walcott.
Callavia bröggeri (Walcott).
Ptychoparia attleborensis Shaler and Foerste.
Ptychoparia sp.
Solenopleura bombifrons Matthew.
Solenopleura howleyi Walcott.
Avalonia manuelensis Walcott.
Agraulos strenuus Billings.
Agraulos strenuus nasutus Walcott.
Agraulos sp.

Walcott [1891b, p. 260] cites the following additional species:

Hyolithes impar Ford.
Hyolithes terranovicus Walcott.
Scenella reticulata Billings.
Platyceras primævum Billings.
Microdiscus speciosus Ford.

41a. (For stratigraphic position and association, see p. 141.) Lower Cambrian: Limestone [see Walcott, 1891b, p. 260] on the mainland beneath Topsail Head, Conception Bay, Newfoundland.

Micromitra (Paterina) labradorica.
Obolella atlantica.
Scenella reticulata Billings.
Hyolithellus micans (Billings).
Hyolithellus micans rugosa Walcott.
Hyolithes impar var.
Hyolithes princeps Billings.
Microdiscus bellimarginatus Shaler and Foerste.
Ptychoparia attleborensis Shaler and Foerste.
Avalonia manuelensis Walcott.
Agraulos strenuus Billings.

Walcott [1891b, p. 260] cites the following additional species:

Microdiscus speciosus Ford.
Microdiscus sp. undt.
Callavia bröggeri (Walcott).
Solenopleura bombifrons Matthew.
Agraulos sp.

43. Ordovician: Shales on the summit of Moses Hill, 2 miles (3.2 km.) west of North Greenwich, near the line between the Schuylerville and Cambridge quadrangles (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1887).

Acrothele pretiosa.

43a. Lower Cambrian: Limestone 1 mile (1.6 km.) east-northeast of Salem, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott and W. P. Rust, 1887).

Botsfordia cælata.
Acrotreta sagittalis taconica.
Protospongia sp.
Hyolithes impar Ford.
Microdiscus connexus Walcott.
Microdiscus lobatus (Hall).
Microdiscus speciosus Ford.
Agnostus desideratus Walcott.
Ptychoparia cf. adamsi (Billings).
Protypus clavatus Walcott.
Zacanthoides eatoni Walcott.

44a (a little north of 44b). Lower Cambrian: Limestone on Valatie Kill, near the line between Nassau and Schodack townships, near line between Troy and Kinderhook quadrangles (U. S. G. S.), Rensselaer County, N. Y. (C. D. Walcott, 1887).

Acrotreta sagittalis taconica.
Microdiscus connexus Walcott.

44b (a little south of 44a). Lower Cambrian: Limestone near North Chatham, in the northern part of the Kinderhook quadrangle (U. S. G. S.), Columbia County, N. Y. (C. D. Walcott, 1887).

Micromitra (Iphidella) pannula.
Lingulella granvillensis.
Acrotreta sagittalis taconica.
Hyolithellus micans (Billings).
Agnostus sp.

45a. Lower Cambrian: Limestone at McNaughton Corner, 1 mile (1.6 km.) east of Salem, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y. (Ira Sayles, 1887).

Acrotreta sagittalis taconica.
Archæocyathus dwighti Walcott.
Archæocyathus rarus (Ford).
Hyolithellus micans (Billings).
Microdiscus lobatus (Hall).
Microdiscus speciosus Ford.
Solenopleura tumida Walcott.
Zacanthoides eatoni Walcott.

45b. Lower Cambrian: Limestone near the roadside about 1,200 feet (366 m.) east of Bristol's house, near Low Hampton, about 5 miles (8 km.) east-northeast of Whitehall, Whitehall quadrangle (U. S. G. S.), Washington County, N. Y. (Ira Sayles, 1887).

Obolus prindlei.
Acrotreta sagittalis taconica.
Platyceras primævum Billings.
Hyolithellus micans (Billings).
Hyolithes americanus Billings.
Hyolithes impar Ford.
Microdiscus speciosus Ford.
Elliptocephala asaphoides Emmons.
Solenopleura tumida Walcott.

47a. Lower Cambrian: Sandstone on the southwest side of Sallings Mountain, 2 miles (3.2 km.) east of Natural Bridge, Rockbridge County, Va. (C. D. Walcott, 1891).

*Kutorgina sp. undt.
Obolella minor.
Hyolithes communis Billings.
Olenellus sp.

47c. Lower Cambrian: Sandstone 2 miles (3.2 km.) west of bridge at Harpers Ferry, Jefferson County, W. Va. (C. D. Walcott, 1892).

Obolella minor.
Olenellus thompsoni (Hall).

47d (see 16f). Lower Cambrian: Sandstones 1 mile (1.6 km.) east-southeast of Smithsburg, Washington County, Md. (C. D. Walcott, 1892)

Obolella minor?.
Olenellus thompsoni (Hall).

47e (see 16f). Lower Cambrian: Sandstone on Observatory Hill, 2 miles (3.2 km.) south of Keedysville, Washington County, Md. (C. D. Walcott, 1892).

Obolella minor.
Olenellus thompsoni (Hall).

47f (see 16f). Lower Cambrian: Sandstone at Eakles Mills, 2 miles (3.2 km.) south of Keedysville, Washington County, Md. (C. D. Walcott, 1892).

Obolella minor.
Olenellus thompsoni (Hall).

47h. Middle Cambrian: Shales on Wolf Creek, 6 miles (9.6 km.) below Rocky Gap, Bland County, Va. (M. R. Campbell, 1893).

Dicellomus appalachia.

48d. Middle Cambrian: Argillaceous shales in railroad cut alongside of gas house, city of York, York County, Pa. (H. E. Dickhaut, 1901).

*Lingulella sp. undt. b.
*Acrothele yorkensis.

49. Lower Cambrian: Sandstone on Codorus Creek 0.125 mile (0.2 km.) below Meyer's mill, near Emigsville, York County, Pa. (Charles Schuchert, 1893).

Rustella edsoni?.
Micromitra (Paterina) bella.
*Yorkia wanneri.
Nisusia festinata.
Olenellus thompsoni crassimarginatus Walcott.

49a. Lower Cambrian: Sandstone on the Liverpool road, south of the schoolhouse, 3 miles (4.8 km.) northwest of York, York County, Pa. (Charles Schuchert, 1893).

Rustella edsoni.
Yorkia wanneri.
Nisusia festinata.
Olenellus thompsoni crassimarginatus Walcott.

49b. Lower Cambrian: Sandstone in the continuation of the ridge mentioned in Locality 49c, 2 miles (3.2 km.) northwest of Emigsville, York County, Pa. (C. D. Walcott, 1892).

Obolella minor.
Olenellus thompsoni (Hall).

49c. Lower Cambrian: Sandstone in ridge just north of the railway station at Emigsville, York County, Pa. (C. D. Walcott, 1892).

Obolella minor.
Olenellus thompsoni (Hall).

49d. Lower Cambrian: Sandstone 3 miles (4.8 km.) east of Waynesboro, Franklin County, Pa. (C. D. Walcott, 1892).

Obolella minor.
Olenellus thompsoni (Hall).

49e. Lower Cambrian: Sandstone 1 mile (1.6 km.) south of Mount Zion Church and 4 miles (6.4 km.) northeast of York, York County, Pa. (C. D. Walcott, 1892).

Obolella minor.
Olenellus thompsoni (Hall).

49f. Lower Cambrian: Sandstones of Mount Holly Gap, South Mountain, Cumberland County, Pa. (C. D. Walcott, 1892).

Obolella minor?.
Hyolithes sp.
Olenellus? sp.

49w. Lower Cambrian: Limestone in railroad cut 0.25 mile (0.4 km.) south of Emigsville, York County, Pa. (C. D. Walcott, 1892).

Micromitra (Paterina) bella.
Nisusia festinata.

50. Lower Cambrian: Shaly limestones 1.125 miles (1.8 km.) north of Stoner, 10 miles (16.1 km.) east-northeast of York, York County, Pa. (C. D. Walcott, 1892).

*Acrothele decipiens.
Olenellus.

50a. Lower Cambrian: Sandstone 2 miles (3.2 km.) northwest of York, York County, Pa. (C. D. Walcott, 1892).

Obolella crassa?.
Olenellus sp.

52. (For stratigraphic position and association, see p. 140.) Lower Cambrian: Arenaceous shales just above the Prospect Mountain quartzite, in a stratigraphic position similar to that of the Pioche formation [Walcott, 1908f, p. 184], at the top of Prospect Mountain, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (J. P. Iddings and C. D. Walcott, 1880).

*Micromitra (Paterina) prospectensis.
Girvanella sp.
Scenella? conula Walcott.
Callavia nevadensis Walcott.
Olenellus fremonti Walcott.
Peachella iddingsi (Walcott).
Dorypyge? quadriceps (Hall and Whitfield).

53 (below 178a). (For stratigraphic position and association, see p. 138.) Lower Cambrian: Sandstones in the lower portion of 3d of the Waucoba Springs section [Walcott, 1908f, pp. 187 and 188], 1 mile (1.6 km.) east of Saline Valley road, about 2.5 miles (4 km.) east-northeast of Waucoba Springs, Inyo County, Cal. (C. D. Walcott, 1897).

Mickwitzia occidens.
Obolella vermilionensis.
*Trematobolus excelsis.
Archæocyathus.
Ethmophyllum gracile Meek.
Hyolithes sp.
Wanneria gracile Walcott.

53a. (For stratigraphic position and association, see p. 138.)

Obolella sp.

54. (For stratigraphic position and association, see p. 140.) Middle Cambrian: Eldorado limestone [Walcott, 1908f, p. 184] on east slope of Prospect Mountain, in New York Canyon, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1886).

Lingulella arguta.
Lingulella punctata.

54a (=31e). (For stratigraphic position and association, see p. 151.) (C. D. Walcott and L. D. Burling, 1906.)

Micromitra (Paterina) labradorica utahensis.
Obolus (Westonia) ella.
Acrothele turneri?.
Isoxys cf. argentea (Walcott).
Ptychoparia.

54b. (For stratigraphic position and association, see p. 148.) Upper Cambrian: About 1,200 feet (365.8 m.) above the Middle Cambrian and 25 feet (7.6 m.) below the top of the Upper Cambrian, in the upper part of the limestone forming 1 of the St. Charles limestone [Walcott, 1908f, p. 191], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (C. D. Walcott and L. D. Burling, 1906).

Lingulella manticula.
Eoorthis desmopleura.
Syntrophia nundina.
Dikellocephalus.

54c. (For stratigraphic position and association, see p. 148.) Upper Cambrian: About 1,100 feet (335.3 m.) above the Middle Cambrian and 120 feet (36.6 m.) below the top of the Upper Cambrian, in the central part of the limestone forming 1 of the St. Charles limestone [Walcott, 1908f, p. 192], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (C. D. Walcott and L. D. Burling, 1906).

Schizambon typicalis.
Eoorthis desmopleura.
*Eoorthis newberryi.
Syntrophia nundina.
Solenopleura.
Menocephalus.
Illænurus.

54d. (For stratigraphic position and association, see p. 148.) Upper Cambrian: About 1,050 feet (320 m.) above the Middle Cambrian and 175 feet (53.3 m.) below the top of the Upper Cambrian, in the lower part of the limestone forming 1 of the St. Charles limestone [Walcott, 1908f, p. 192], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (C. D. Walcott and L. D. Burling, 1906).

Lingulella (Lingulepis) acuminata.
Eoorthis desmopleura.
Eoorthis newberryi.
Agnostus.
Menocephalus.
Solenopleura.
Asaphus?.

54e. (For stratigraphic position and association, see p. 149.) Upper Cambrian: About 200 feet (61 m.) above the Middle Cambrian and 1,025 feet (212.4 m.) below the top of the Upper Cambrian, in limestones forming 3 of the St. Charles limestone [Walcott, 1908f, p. 193], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (Mrs. C. D. Walcott, Stuart Walcott, and L. D. Burling, 1906).

Obolus discoideus.
Obolus (Westonia) ella.
Lingulella manticula.
Billingsella coloradoensis.
*Huenella lesleyi.
Hyolithes.
Cyrtolites.
Agnostus.
Ptychoparia.
Anomocare.

54f. (For stratigraphic position and association, see p. 149.) Upper Cambrian: 150 feet (45.7 m.) above the Middle Cambrian and 1,075 feet (327.7 m.) below the top of the Upper Cambrian, in the light-gray sandstone forming 4 of the St. Charles limestone [Walcott, 1908f, p. 193], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (C. D. Walcott and L. D. Burling, 1906).

Obolus discoideus.
Obolus (Fordinia) bellulus?.
Acrotreta idahoensis alta.
Billingsella coloradoensis.

54g. (For stratigraphic position and association, see p. 149.) Upper Cambrian: Just above the Middle Cambrian, near the base of the hedded light-gray sandstone forming 4 of the St. Charles limestone [Walcott, 1908f, p. 193], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (C. D. Walcott and L. D. Burling, 1906).

Lingulella (Lingulepis) acuminata.

54h (=31l). (For stratigraphic position and association, see p. 149.) (L. D. Burling and Stuart Walcott, 1906.)

Protospongia.
Obolus mcconnelli pelias.
Obolus (Westonia) wasatchensis.
Lingulella desiderata.
Hyolithes.
Agnostus.
Ptychoparia.

54i (=31k). (For stratigraphic position and association, see p. 150.) Middle Cambrian: About 2,950 feet (899.2 m.) above the Brigham quartzite and 1,225 feet (373.4 m.) below the Upper Cambrian, in the limestone forming 1e of the Bloomington formation [Walcott, 1908f, p. 194], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (L. D. Burling, 1905).

Micromitra cf. sculptilis.
Hyolithes.
Agraulos.
Ptychoparia.

54j. (For stratigraphic position and association, see p. 148.) Upper Cambrian: About 700 feet (213.4 m.) above the Middle Cambrian and 525 feet (160 m.) below the top of the Upper Cambrian, in the arenaceous limestones forming 2c of the St. Charles limestone [Walcott, 1908f, p. 192], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (C. D. Walcott, Stuart Walcott, and L. D. Burling, 1906).

Obolus (Westonia) iphis.
Lingulella desiderata.

54k. (For stratigraphic position and association, see p. 150.) Middle Cambrian: About 2,100 feet (640 m.) above the Lower Cambrian and 2,100 feet (640 m.) below the Upper Cambrian, in the shales forming 2d of the Bloomington formation [Walcott, 1908f, p. 195], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (C. D. Walcott and L. D. Burling, 1906).

Obolus (Westonia) wasatchensis.
Agraulos.
Ptychoparia.

54l (=31d). (For stratigraphic position and association, see p. 152.) (C. D. Walcott, 1906.)

Micromitra (Iphidella) pannula.
Obolus (Westonia) ella?.
Lingulella desiderata.
Hyolithes.
Orthotheca major Walcott.
Leperditia.
Ptychoparia.
Bathyuriscus productus (Hall and Whitfield).

54m (=31f). (For stratigraphic position and association, see p. 150.) Middle Cambrian: About 1,225 feet (373.4 m.) above the Brigham quartzite and 2,950 feet (899.2 m.) below the Upper Cambrian, in the upper part of the limestone forming 1a of the Ute limestone [Walcott, 1908f, p. 195], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (C. D. Walcott and L. D. Burling, 1906).

*Micromitra (Paterina) labradorica utahensis.
Billingsella sp.
Hyolithes.
Ptychoparia subcoronata (Hall and Whitfield).
Dorypyge? quadriceps (Hall and Whitfield).

54n. (For stratigraphic position and association, see p. 151.) Middle Cambrian: About 550 feet (167.6 m.) above the Brigham quartzite and 3,640 feet (1,109.5 m.) below the Upper Cambrian, in the limestone forming 2e of the Ute limestone [Walcott, 1908f, p. 197], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (C. D. Walcott, 1906).

*Micromitra (Paterina) stuarti.
Micromitra (Paterina) superba.
Hyolithes.
Dorypyge (fragment).
Ptychoparia.

54o (=31c). (For stratigraphic position and association, see p. 151.) (C. D. Walcott and L. D. Burling, 1906.)

Micromitra (Paterina) labradorica utahensis.
Billingsella coloradoensis.
*Eoorthis zeno.
Syntrophia cambria.
Hyolithes.
Scenella.
Ptychoparia subcorouata (Hall and Whitfield.)
Dorypyge? quadriceps (Hall and Whitfield.)

54p. (For stratigraphic position and association, see p. 151.) Middle Cambrian: About 525 feet (160 m.) above the Brigham quartzite and 3,665 feet (1,127.1 m.) below the Upper Cambrian, in the shales forming 2f of the Ute limestone [Walcott, 1908f, p. 197], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (C. D. Walcott and L. D. Burling, 1906).

Micromitra (Paterina) superba.
Obolus mcconnelli.
Ptychoparia sp. undt.

54q (same horizon as 32x). (For stratigraphic position and association, see p. 150.) Middle Cambrian: A drift block supposed to have come from a horizon 1,700 feet (518.2 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], found near the mouth of Wasatch Canyon, east of Lakeview ranch, 5 miles (8 km.) north of Brigham, Boxelder County, Utah (C. D. Walcott, 1906).

Micromitra (Iphidella) pannula?.
Obolns sp. undt.
*Obolus (Westonia) wasatchensis.
Acrothele subsidua.
Nisusia alberta.
Nisusia alberta?.

54r. (For stratigraphic position and association, see p. 148.) Upper Cambrian: Drift pieces of limestone from the west slope of the Wasatch Range, east of Lakeview ranch, about 5 miles (8 km.) north of Brigham, Boxelder County, Utah (C. D. Walcott and L. D. Burling, 1906).

Obolus meconnelli pelias.
Eoorthis desmopleura.

54s (=5b). (For stratigraphic position and association, see p. 152.) Middle Cambrian: Dark blue-gray Langston limestone [Walcott, 1908f, p. 198], just above the Cambrian quartzitic sandstones, north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho (C. D. Walcott and L. D. Burling, 1906).

*Micromitra haydeni (54s).
Micromitra (Iphidella) pannula.
*Micromitra (Iphidella) pannula maladensis (5b).
Micromitra (Iphidella) pannula ophirensis.
Lingulella desiderata.
Lingulella helena.
Lingulella isse.
*Acrothele artemis (5b).
Acrothele subsidna.
Acrothele subsidua var.
Acrotreta idahoensis sulcata.
Acrotreta pyxidicula.
Acrotreta?.
*Acrothyra minor (5b).
Billingsella coloradoensis.
Hyolithes.
Orthotheca.
Stenotheca.
Platyceras.
Agnostus.
Microdiscus.
Solenoplenra.
Ptychoparia 2 sp.
Oryctocephalus.
Dorypyge 2 sp.
Neolenus 2 sp.
Asaphiscus.
Ogygopsis?.

54t (=4y, 5a, 5c, 5e, and 54w). (For stratigraphic position and association, see p. 149.) Upper Cambrian: Limestone of the St. Charles limestone [Walcott, 1908a, p. 6], about 250 feet (76 m.) above the Middle Cambrian, on the north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho (C. D. Walcott and L. D. Burling, 1906).

Obolus wortheni.
Obolns (Westonia) ella.
Lingulella desiderata.
Acrotreta idahoensis.
Acrotreta idahoensis sulcata.
Billingsella coloradoensis.
Ptychoparia.
Anomocare.

54u. (For stratigraphic position and association, see p. 149.) Upper Cambrian: Limestone of the St. Charles limestone [Walcott, 1908a, p. 6], about 100 feet (30.5 m.) above the Middle Cambrian, on the north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho (C. D. Walcott and L. D. Burling, 1906).

*Obolus wortheni.
Acrotreta idahoensis.
Billingsella coloradoensis
Agnostus.
Ptychoparia 2 sp.
Ptychaspis.
Anomocare.

54v. (For stratigraphic position and association, see p. 150.) Middle Cambrian: Limestone in the lower part of the Bloomington formation [Walcott, 1908a, p. 7], about 1,600 feet (488 m.) below the Upper Cambrian, on the south side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho (C. D. Walcott and L. D. Burling, 1906).

Obolus wortheni.
Ptychoparia 2 sp.

54w (=54t). (For stratigraphic position and association, see p. 149.) (C. D. Walcott and L. D. Burling, 1906.)

Obolus tetonensis ninus.
Obolus wortheni.
Agnostus 2 sp.
Ptychaspis.
Ptychoparia 2 sp.
Liostracus.
Anomocare 3 sp.
Damesella sp.

54x. (For stratigraphic position and association, see p. 149.) Upper Cambrian: St. Charles limestone [Walcott, 1908a, p. 6], about 200 feet (60.4 m.) above the Middle Cambrian, on the north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho (C. D. Walcott and L. D. Burling, 1906).

Obolus wortheni.
Billingsella coloradoensis
Agnostus.
Ptychoparia.
Liostracus.
Ptychaspis.
Anomocare.
Damesella.

54y. (For stratigraphic position and association, see p. 151.) Middle Cambrian: About 510 feet (155.4 m.) above the Brigham quartzite and 3,680 feet (1,121.7 m.) below the Upper Cambrian, in the limestone forming 2g of the Ute limestone [Walcott, 1908f, p. 197], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (C. D. Walc and L. D. Burling, 1906).

Micromitra (Paterina) superba.
Hyolithes.
Ptychoparia.

55. (For stratigraphic position and association, see p. 140.) Middle Cambrian: Shaly limestone at the top of the Eldorado limestone [Walcott, 1908f, p. 184], east slope of Prospect Mountain, in New York Canyon, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1886).

Acrotreta definita.
Billingsella whitfieldi.
Agnostus bidens Meek.
Agnostus tumidosus Hall and Whitfield.
Dorypyge ? quadriceps (Hall and Whitfield).

55b. (For stratigraphic position and association, see p. 140.) Middle Cambrian: Top of the Eldorado limestone [Walcott, 1908f, p. 184], west side of Secret Canyon, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1886).

*Billingsella whitfieldi.
*Orusia? eurekensis.
Orusia lenticularis.
Stenotheca elongata Walcott.
Agnostus bidens Meek.
Olenoides expansus (Walcott).
Zacanthoides spinosus (Walcott).

55c (=163). (For stratigraphic position and association, see p. 152.) Middle Cambrian: Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], about 50 feet (15.2 m.) above the Brigham quartzite and 2,755 feet (839.7 m.) below the Upper Cambrian, in a ravine running up into Danish Flat from Mill Canyon, about 6 miles (9.6 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho (Mr. and Mrs. C. D. Walcott, Helen Walcott, Stuart Walcott, and L. D. Burling, 1906).

Micromitra (Iphidella) pannula?.
Obolus (Westonia) ella.
Lingulella desiderata.
Acrothele subsidua.
Acrotreta definita.
Acrotreta idahoensis sulcata.
*Nisusia rara.
Nisusia (Jamesella) spencei.
Nisusia (Jamesella) nautes.
Hyolithes.
Agnostus, several species.
Microdiscus sp.
Olenoides, several species.
*Zacanthoides idahoensis Walcott.
Zacanthoides sp.
Oryctocephalus reynoldsi Reed.
Oryctocara geikiei Walcott.
Ptychoparia, many species.
Bathyuriscus howelli Walcott.
Bathyuriscus productus (Hall and Whitfield).
Bathyuriscus sp.

55d. (For stratigraphic position and association, see p. 150.) Middle Cambrian: About 2,000 feet (609.6 m.) above the Cambrian quartzitic beds, in a shale which is probably to be referred to the Bloomington formation [Walcott, 1908a, p. 7], on the south side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho (C. D. Walcott, 1906).

Obolus (Westonia) wasatchensis.

55e (=32p). (For stratigraphic position and association, see p. 152.) Middle Cambrian: Spence shale member of the Ute limestone, about 100 feet (30.5 m.) above the Brigham quartzite [Walcott, 1908f, p. 197], at the mouth of the first small canyon south of Wasatch Canyon, east of Lakeview Ranch, 5 miles (8 km.) north of Brigham, Boxelder County, Utah (C. D. Walcott and L. D. Burling, 1906).

Micromitra (Iphidella) pannula.
Obolus (Westonia) ella.
Lingulella desiderata.
Acrothele subsidua.
Eocystites longidactylus Walcott.
Agnostus.
Ptychoparia piochensis Walcott.
Zacanthoides idahoensis Walcott
Neolenus 2 sp.
Bathyuriscus howelli Walcott.
Bathyuriscus productus (Hall and Whitfield).
Ogygopsis.

55h (=31m). (For stratigraphic position and association, see p. 149.) (C. D. Walcott, Stuart Walcott, and L. D. Burling, 1906.)

Obolus.
Lingulella.
Billingsella coloradoensis.
Agnostus.
Ptychoparia.
Anomocare.

55n (=31h). (For stratigraphic position and association, see p. 150.) Middle Cambrian: About 1,850 feet (564 m.) above the Brigham quartzite and 2,350 feet (716 m.) below the Upper Cambrian, in the limestone forming 2g of the Bloomington formation [Walcott, 1908f, p. 195], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah (C. D. Walcott and L. D. Burling, 1906).

Micromitra sculptilis.
Ptychoparia.
Dorypyge.

55t (=31z). (For stratigraphic position and association, see p. 151.) (F. B. Weeks, 1905.)

Obolus (Westonia) ella.
Acrothele subsidua?.
Acrotreta ophirensis.

55u. (For stratigraphic position and association, see p. 158.) Middle Cambrian: Limestones about 200 feet (61 m.) above the Lower Cambrian [Walcott, 1908f, p. 171], 0.25 mile (0.4 km.) below the Maxfield mine, in Big Cottonwood Canyon, on the west front of the Wasatch Mountains, southeast of Salt Lake City, Salt Lake County, Utah (F. B. Weeks, 1905).

Micromitra (Iphidella) pannula.
*Linnarssonella urania.

56. (For stratigraphic position and association, see p. 139.) Upper? Cambrian: Limestone at Sierra Springs, eastern base of Lookout Mountain, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1880).

Lingulella desiderata.
Agnostus prolongus Hall and Whitfield.
Agnostus tumidosus Hall and Whitfield.

56a. Lower Cambrian: A limestone bowlder in the Sillery conglomerate on the south shore of St. Lawrence River, 4 miles (6.4 km.) below Quebec, Canada (C. D. Walcott, 1889).

*Nisusia (Jamesella) amii.
Olenellus? sp.
Olenoides ellsi Walcott.
Ptychoparia cf. subcoronata (Hall and Whitfield).
Ptychoparia sp.

56b. Lower Cambrian: A limestone bowlder in conglomerate on the south shore of the island of Orleans, below Quebec, Canada (C. D. Walcott, 1889).

Obolella crassa.
Hyolithes americanus Billings.
Microdiscus connexus Walcott.
Ptychoparia sp.

56c. (For stratigraphic position and association, see p. 147.) Lower Cambrian: Rome ("Montevallo") shale along road just north of Buck Creek, 1.125 miles (1.8 km.) northeast of Helena, Shelby County, Ala. (T. E. Williard, 1906).

*Micromitra (Paterina) major.
*Micromitra (Paterina) williardi.
*Obolus smithi.
Wimanella shelbyensis.
Pædeumias transitans Walcott.
*Wanneria halli Walcott.
Agraulos?.
Hyolithes.

56f. (For stratigraphic position and association, see p. 149.) Middle Cambrian: Nounan limestone [Walcott, 1908a, p. 6], on a ridge north of the creek which flows into Mill Canyon from the west, about 5 miles (8 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho (C. D. Walcott and L. D. Burling, 1906).

Obolus matinalis.
*Lingulella manticula var.
Orthotheca.
Agraulos.
Solenopleura.
Ptychoparia 2 sp.
Anomocare.
Anomocarella.

56g. (For stratigraphic position and association, see p. 149). Upper Cambrian: Limestone of the St. Charles limestone [Walcott, 1908a, p. 6], in the valley of the stream which flows into Mill Canyon from the west, about 6 miles (9.6 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho (C. D. Walcott and L. D. Burling, 1906).

Obolus discoideus.
Acrotreta idahoensis.
Billingsella coloradoensis.
Platyceras.
Agnostus.
Ptychoparia.

56o. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone in upper third of Conasauga limestone, South Bessemer, Jefferson County, Ala. (T. E. Williard, 1906).

Acrotreta (same one as in 56u).

56q. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone at the very top of the Conasauga limestone in quarry at Ketona, about 5 miles (8 km.) northeast of Birmingham, Jefferson County, Ala. (T. E. Williard, 1906).

Lingulella quadrilateralis.
Ptychoparia sp.

56u. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone in upper third of Conasauga limestone 700 feet (213.4 m.) southeast of Valley Creek bridge, near Nineteenth Street Road, Bessemer, Jefferson County, Ala. (T. E. Williard, 1906).

Acrotreta (same one as in 56o).

57. (For stratigraphic position and association, see p. 140.) Middle Cambrian: Shaly limestone of the Eldorado limestone [Walcott, 1908f, p. 184], at the 700-foot (213.4 m.) level of the Richmond mine, Ruby Hill [Hague, 1892, p. 43 and Pl. I, opposite p. 116], Eureka district, Eureka County, Nev. (C. D. Walcott, 1880).

Lingulella desiderata.
Lingulella punctata.
Acrotreta definita.
Agnostus bidens Meek.
Agnostus richmondensis Walcott.
Agnostus seclusus Walcott.

57b. (For stratigraphic position and association, see p. 140.) Middle Cambrian: Limestones at the north end of Mineral Hill, just south of Ruby Hill [Hague, 1892, p. 43, and Pl. I, opposite p. 116], Eureka district, Eureka County, Nev. (C. D. Walcott, 1880).

Lingulella desiderata.

57c (=57k). (For stratigraphic position and association, see p. 127.) Middle Cambrian: About 2,500 feet (762 m.) above the Lower Cambrian and 2,475 feet (754 m.) below the Upper Cambrian, in the limestone forming 1 of the Stephen formation [Walcott, 1908f, p. 209], on Mount Bosworth, north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide between British Columbia and Alberta, Canada (C. D. Walcott and L. D. Burling, 1907).

Micromitra zenobia.
Obolus mcconnelli.
Nisusia alberta var.
Hyolithes carinatus Matthew.
Ptychoparia 3 sp.
Menocephalus?.
Neolenus sp.
Bathyuriscus?.

57d. (For stratigraphic position and association, see p. 125.) Upper Cambrian: About 3,215 feet (980 m.) above the Middle Cambrian and 375 feet (114.3 m.) below the top of the Upper Cambrian,[a] in green shales near the summit of 2b of the Sherbrooke limestone [Walcott, 1908f, p. 204], on ridge west of Mount Bosworth, on the Continental Divide between Alberta and British Columbia, Canada (C. D. Walcott and L. D. Burling, 1907).

Lingulella isse.

57e. (For stratigraphic position and association, see p. 129.) Lower Cambrian: About 115 feet (35 m.) below the Middle Cambrian, in limestone correlated with the top of 1c of the Mount Whyte formation on Mount Bosworth [Walcott, 1908f, p. 213], just above the tunnel on the north shoulder of Mount Stephen, about 3 miles (4.8 km.) east of Field, British Columbia, Canada (C. D. Walcott and L. D. Burling, 1907).

Acrothele colleni.
Acrotreta sagittalis taconica.
Scenella varians Walcott.
Stenotheca elongata Walcott.
Albertella sp.
Olenellus canadensis Walcott.
Bathyuriscus sp.

57f. (For stratigraphic position and association, see p. 127.) Middle Cambrian: About 2,200 feet (670.5 m.) above the Lower Cambrian and 2,800 feet (853.4 m.) below the Upper Cambrian, in the limestone forming 1 of the Stephen formation [Walcott, 1908f, p. 209], about 0.5 mile (0.8 km.) east of the great "fossil bed" on the northwest slope of Mount Stephen, above Field on the Canadian Pacific Railway, British Columbia, Canada (C. D. Walcott and L. D. Burling, 1907).

Obolus mcconnelli.
Acrotreta depressa.
Nisusia (Jamesella) cf. nautes.
Hyolithes carinatus Matthew.
Orthotheca sp.
Scenella varians Walcott.
Ptychoparia sp.

[a] See the footnote on page 125.

57g. (For stratigraphic position and association, see p. 128.) Middle Cambrian: About 1,700 feet (518 m.) above the Lower Cambrian and 3,250 feet (991 m.) below the Upper Cambrian, in the siliceous shales forming 2d of the Stephen formation [Walcott, 1908f, p. 211], on Mount Bosworth, north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide between British Columbia and Alberta, Canada (C. D. Walcott and L. D. Burling, 1907).

Micromitra (Iphidella) pannula.
Obolus (Westonia) ella.
Cruziana.
Hyolithes.
Leperditia.
Ptychoparia.
Bathyuriscus.

57j. (For stratigraphic position and association, see p. 127.) Middle Cambrian: About 2,000 feet (609.6 m.) above the Lower Cambrian, in the limestone forming 2 of the Stephen formation [Walcott, 1908c, p. 237 (6)], just east of the "fossil bed" on the northwest slope of Mount Stephen, above Field on the Canadian Pacific Railway, British Columbia, Canada (C. D. Walcott and L. D. Burling, 1907).

Micromitra (Iphidella) pannula.
Nisusia alberta var.
Hyolithes.
Bathyuriscus rotundatus (Rominger).
Neolenus serratus (Rominger).

57k (=57c). (For stratigraphic position and association, see p. 127.) (C. D. Walcott and L. D. Burling, 1907.)

Obolus mcconnelli.
Nisusia alberta var.
Agnostus.
Agraulos.
Ptychoparia.
Neolenus.

57m. (For stratigraphic position and association, see p. 129.) Lower Cambrian: About 50 feet (15 m.) below the Middle Cambrian, in a siliceous shale correlated with 1b of the Mount Whyte formation on Mount Bosworth [Walcott, 1908f, p. 213], just above the tunnel on the north shoulder of Mount Stephen, about 3 miles (4.8 km.) east of Field, British Columbia, Canada (C. D. Walcott and L. D. Burling, 1907).

Micromitra (Paterina) sp.
Acrotreta sagittalis taconica.
Nisusia (Jamesella) lowi.
Cystid plates.
Scenella varians Walcott.
Hyolithes.
Hyolithellus cf. micans (Billings).
Olenellus canadensis Walcott.

57n. (For stratigraphic position and association, see p. 127.) Middle Cambrian: About 3,000 feet (914.4 m.) above the Lower Cambrian and about 700 feet (213.4 m.) above the base of a limestone correlated with 4 of the Eldon limestone on Mount Bosworth [Walcott, 1908f, p. 209], on the northwest slope of Mount Stephen, above Field on the Canadian Pacific Railway, British Columbia (C. D. Walcott and L. D. Burling, 1907).

Lingulella cf. isse.
Protospongia (spicules).
Hyolithes.
Agnostus cf. montis Matthew.
Zacanthoides spinosus (Walcott).
Ptychoparia.
Bathyuriscus.
Ogygopsis.

57r (=58s). (For stratigraphic position and association, see p. 129.) (L. D. Burling, 1907.)

Micromitra (Paterina) labradorica var.
Micromitra (Iphidella) pannula.
Acrotreta sagittalis taconica.
Ptychoparia 3 sp.

57s. (For stratigraphic position and association, see p. 129.) Lower Cambrian: About 160 feet (49 m.) below the Middle Cambrian, near the base of the gray oolitic limestone forming 1b of the Mount Whyte formation [Walcott, 1908f, p. 212], on Mount Bosworth, north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide between British Columbia and Alberta, Canada (C. D. Walcott, 1907).

Nisusia (Jamesella) lowi.
Acrotreta sagittalis taconica.
Microdiscus?.
Agraulos sp.
Ptychoparia sp.

57y. (For stratigraphic position and association, see p. 128.) Middle Cambrian: About 1,900 feet (579 m.) above the Lower Cambrian and 3,050 feet (930 m.) below the Upper Cambrian, in the siliceous shales forming 2a of the Stephen formation [Walcott, 1908f, p. 211], on Mount Bosworth, north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide between British Columbia and Alberta, Canada (C. D. Walcott and L. D. Burling, 1907).

Obolus (Westonia) ella?.

58. (For stratigraphic position and association, see p. 139.) Middle Cambrian: Shaly limestones in upper beds of Secret Canyon shale, east side of New York and Secret canyons, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1880).

Micromitra sculptilis.
Micromitra (Paterina) crenistria?.
Obolus discoideus.
Obolus mæra.
Obolus mcconnelli.
Obolus nundina.
*Obolus (Acritis) rugatus.
*Lingulella clarkei.
Lingulella desiderata.
*Lingulella punctata.
*Acrothele dichotoma.
*Acrotreta idahoensis alta.
Acrotreta microscopica.
Protospongia fenestrata Salter.
Hyolithes primordialis Hall.
Agnostus bidens Meek.
Agnostus communis Hall and Whitfield.
Agnostus neon Hall and Whitfield.
*Agnostus seclusus Walcott.
Agnostus tumidosus Hall and Whitfield.
Ptychoparia anytus (Hall and Whitfield).
Ptychoparia haguei (Hall and Whitfield).
*Ptychoparia læviceps Walcott.
Ptychoparia? linnarssoni Walcott.
Ptychoparia unisulcatus (Hall and Whitfield).
Ogygia? problematica Walcott.

58f. (For stratigraphic position and association, see p. 125.) Upper Cambrian: About 3,100 feet (945 m.) above the Middle Cambrian, in the limestone interbedded in the shales forming 2b of the Sherbrooke limestone [Walcott, 1908f, p. 204], ridge west of Mount Bosworth, on the Continental Divide between Alberta and British Columbia, Canada (C. D. Walcott and L. D. Burling, 1907).

Obolus sp.

58i. (For stratigraphic position and association, see p. 127.) Middle Cambrian: About 1,225 feet (373 m.) above the Lower Cambrian, in the shales of the Stephen formation [Walcott, 1908a, p. 3], northeast slope of Castle Mountain, facing the amphitheater north of the Canadian Pacific Railway, Alberta, Canada (C. D. Walcott and L. D. Burling, 1907).

Obolus mcconnelli.

58j. (For stratigraphic position and association, see p. 127.) Middle Cambrian: About 1,900 feet (579 m.) above the Lower Cambrian and 3,100 feet (945 m.) below the Upper Cambrian, near the base of the limestone forming 2 of the Stephen formation [Walcott, 1908c, p. 238 (7)], on the east side of Mount Stephen, about 3,000 feet (914 m.) above the Canadian Pacific Railway track 3 miles (4.8 km.) east of Field, British Columbia (C. D. Walcott and L. D. Burling, 1907).

Micromitra (Iphidella) pannula.
Obolus mcconnelli.
Acrothele subsidua.
Acrotreta depressa.
Hyolithes sp.
Agnostus montis Matthew.
Agraulos sp.
Ptychoparia sp.
Zacanthoides sp.
Bathyuriscus sp.
Albertella sp.

58k (same horizon as 58p). (For stratigraphic position and association, see p. 129.) Lower Cambrian: Just below the Middle Cambrian, in limestones forming 1 of the Mount Whyte formation [Walcott, 1908c, p. 240 (9)], just above the tunnel on the north shoulder of Mount Stephen, about 3 miles (4.8 km.) east of Field, British Columbia, Canada (C. D. Walcott and L. D. Burling, 1907).

Acrotreta sagittalis taconica.
Nisusia alberta var.
*Nisusia (Jamesella) lowi.
Stenotheca elongata Walcott.
Scenella varians Walcott.
Platyceras sp.
Hyolithes billingsi Walcott.
Ptychoparia sp.
Crepicephalus sp.
Protypus sp.
Albertella sp.

58l. (For stratigraphic position and association, see p. 128.) Middle Cambrian: About 1,830 feet (557.8 m.) above the Lower Cambrian, in the limestone forming 3b of the Stephen formation [Walcott, 1908c, p. 238 (7)], on the east side of Mount Stephen, about 3,000 feet (914.4 m.) above the Canadian Pacific Railway track, 3.5 miles (5.6 km.) east of Field, British Columbia (C. D. Walcott and Mr. and Mrs. L. D. Burling, 1907).

Micromitra zenobia.
Lingulella desiderata.
* Billingsella marion.
Hyolithes sp.
Microdiscus sp.
Ptychoparia sp.

58p (same horizon as 58k). (For stratigraphic position and association, see p. 129.) Lower Cambrian: Drift block of limestone believed to have come from the limestone forming 1 of the Mount Whyte formation [Walcott, 1908c, p. 240 (9)], found near the Canadian Pacific Railway track just west of the tunnel, 3 miles (4.8 km.) east of Field, British Columbia, Canada (C. D. Walcott and L. D. Burling, 1907).

Nisusia alberta var.
Nisusia (Jamesella) lowi.
Hyolithes billingsi Walcott.
Ptychoparia.

58r. (For stratigraphic position and association, see p. 127.) Middle Cambrian: About 1,800 feet (548.6 m.) above the Lower Cambrian and 3,200 feet (975.4 m.) below the Upper Cambrian, in the limestones forming 2 of the Stephen formation [Walcott, 1908f, p. 211], in the amphitheater between Mounts Stephen and Dennis, above Field on the Canadian Pacific Railway, British Columbia, Canada (C. D. Walcott and L. D. Burling, 1907).

Obolus mcconnelli.
Acrotreta depressa.
Hyolithellus annulatus (Matthew).
Ptychoparia.
Neolenus serratus (Rominger).
Ogygopsis klotzi (Rominger).

58s (=57r). (For stratigraphic position and association, see p. 129.) Lower Cambrian: About 150 feet (46 m.) below the Middle Cambrian, near the base of the limestones forming 3 of the Mount Whyte formation [Walcott, 1908c, p. 241 (10)], just above the tunnel on the north shoulder of Mount Stephen, about 3 miles (4.8 km.) east of Field, British Columbia, Canada (C. D. Walcott and L. D. Burling, 1907).

Micromitra (Paterina) labradorica var.
Micromitra (Iphidella) pannula.
Acrotreta sagittalis taconica.
Ptychoparia 3 sp.

58t. (For stratigraphic position and association, see p. 129.) Lower Cambrian: Sandy shale about 150 feet (45.7 m.) below the Middle Cambrian, just below the big cliff on the east shoulder of Castle Mountain, north of the Canadian Pacific Railway, Alberta, Canada (L. D. Burling and Stuart Walcott, 1907).

Obolus parvus.

58w. (For stratigraphic position and association, see p. 127.) Middle Cambrian: About 1,300 feet (396 m.) above the Lower Cambrian, in the shales of the Stephen formation [Walcott, 1908a, p. 3], northeast slope of Castle Mountain, facing the amphitheater north of the Canadian Pacific Railway, Alberta, Canada (C. D. Walcott and L. D. Burling, 1907).

Obolus mcconnelli.

58z. (For stratigraphic position and association, see p. 128.) Middle Cambrian: About 1,875 feet (572 m.) above the Lower Cambrian and 3,100 feet (945 m.) below the Upper Cambrian, in the limestone forming 2b of the Stephen formation [Walcott, 1908f, p. 211], on Mount Bosworth, north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide between British Columbia and Alberta, Canada (C. D. Walcott and L. D. Burling, 1907).

Micromitra zenobia.
Nisusia alberta var.
Menocephalus.
Ptychoparia.
Neolenus.

59. (For stratigraphic position and association, see p. 140.) Middle Cambrian: Limestone at the base of the western slope of Combs Peak, near the plain of Antelope Valley, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1880).

Lingulella arguta.
Acrotreta attenuata.
Agnostus tumidosus Hall and Whitfield.
Dorypyge ? quadriceps (Hall and Whitfield).

59f. (For stratigraphic position and association, see p. 152.) Middle Cambrian: Limestones immediately underlying the Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], in a saddle north of the creek which flows into Mill Canyon from the west, about 5 miles (8 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho (C. D. Walcott, jr., and L. D. Burling, 1907).

Micromitra (Iphidella) pannula.
Lingulella desiderata.
Acrotreta pyxidicula.
Solenopleura sp.
Neolenus sp.
Anomocare sp.
Ptychoparia sp.
Agraulos sp.
Stenotheca sp.
Zacanthoides sp.

59g. (For stratigraphic position and association, see p. 151.) Middle Cambrian: Limestones immediately overlying the Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], in a saddle north of the creek which flows into Mill Canyon from the west, about 5 miles (8 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Liberty, Bear Lake County, Idaho (C. D. Walcott, jr., and L. D. Burling, 1907).

Lingulella sp.
Acrothele subsidua.
Acrotreta cf. idahoensis.
Ptychoparia 3 sp.
Neolenus.
Microdiscus.
Zacanthoides idahoensis Walcott.
Menocephalus.

59m. (For stratigraphic position and association, see p. 147.) Lower Cambrian: Weisner quartzite in the Roan iron mine, Bartow County, Ga. (S. W. McCallie, 1900).

Obolella cf. atlantica.
Obolella cf. crassa.
Archæocyathus?.
Stenotheca cf. rugosa (Hall).
Olenellus thompsoni (Hall).

60. (For stratigraphic position and association, see p. 139.) Middle Cambrian: Limestones in upper beds of Secret Canyon shale, across the canyon from the dump of the old Richmond mine shaft, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1880).

Lingulella clarkei.
Lingulella desiderata.
Lingulella sp.
Acrotreta pyxidicula.
Agnostus prolongus Hall and Whitfield.
Ptychoparia maculosa (Hall and Whitfield).
Ptychoparia unisulcata (Hall and Whitfield).

60b. (For stratigraphic position and association, see p. 130.) Lower Cambrian: About 2,300 feet (702 m.) below the Mount Whyte formation and 200 to 300 feet (61 to 92 m.) above the Lake Louise shale, in the St. Piran sandstone [Walcott, 1908a, p. 4], at Vermilion Pass, on the Continental Divide between British Columbia and Alberta, west-southwest of Castle on the Canadian Pacific Railway, Alberta, Canada (C. D. Walcott, 1909).

* Obolella vermilionensis.
Wanneria gracile Walcott.

61. (For stratigraphic position and association, see p. 139.) Upper Cambrian: Limestone in the Dunderberg shale [Walcott, 1908f, p. 184], a little south of the Hamburg mine, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott and C. H. H., 1882).

Micromitra sculptilis.
Obolus anceps.
Obolus mæra.
Obolus nundina.
Lingulella desiderata.
Lingulella manticula.
Lingulella punctata.
Acrotreta attenuata.
Acrotreta idahoensis.
Acrotreta idahoensis alta.
*Acrotreta spinosa.
Acrotreta sp.
Agnostus prolongus Hall and Whitfield.
Agnostus tumidosus Hall and Whitfield.
Ptychoparia granulosa (Hall and Whitfield).
Ptychoparia maculosa (Hall and Whitfield).
Ptychoparia unisulcata (Hall and Whitfield).

62. (For stratigraphic position and association, see p. 139.) Upper Cambrian: Limestone in the Dunderberg shale [Walcott, 1908f, p. 184], in canyon immediately north of Adams Hill, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1880).

Micromitra sculptilis.
Obolus discoideus.
Lingulella manticula.
Lingulella punctata.
Acrotreta spinosa.
Agnostus prolongus Hall and Whitfield.
Ptychoparia breviceps (Walcott).
Arethusina americana Walcott.

62a. (For stratigraphic position and association, see p. 139.) Upper Cambrian: Limestone on east side of Sierra Canyon, opposite the Jackson mine, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1880).

Acrotreta spinosa.
Ptychoparia granulosa (Hall and Whitfield).
Ptychoparia simulator (Hall and Whitfield).

63. (For stratigraphic position and association, see p. 139.) Lower Ordovician: At the base of the Pogonip limestone northeast of Adams Hill, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1880).

*Obolus anceps.
*Elkania ambigua.
Acrotreta idahoensis alta.
Schizambon?.
Syntrophia nundina.

64. (For stratigraphic position and association, see p. 139.) Upper Cambrian: Limestone near the Bullwhacker mine, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1880).

Obolus discoideus.
Obolus (Westonia) iphis.
Agnostus prolongus Hall and Whitfield.

65. (For stratigraphic position and association, see p. 139.) Upper Cambrian: Limestone on the east side of Sierra Canyon, opposite Pinnacle Peak, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (Arnold Hague and J. P. Iddings, 1880).

Acrotreta idahoensis alta.
Acrotreta spinosa.

66. (For stratigraphic position and association, see p. 139.) Upper Cambrian: Dunderberg shale [Walcott, 1908f, p. 184], on the first ridge north of the Dunderberg mine, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1880).

Obolus discoideus.
Agnostus prolongus Hall and Whitfield.
Arethusina americana Walcott.

67 (=67c). Upper Cambrian: Sandstone on Tatur Hill, 7 miles (11.2 km.) northwest of Burnet, Burnet County, Tex. (C. D. Walcott, 1884).

Obolus matinalis.
Obolus sinoe.
Lingulella acutangula.
Acrotreta microscopica.
Ptychoparia affinis (Walcott).
Ptychoparia diademata (Hall).
Ptychoparia llanoensis Walcott.
Ptychoparia? metra Walcott.
Ptychoparia? urania Walcott.
Ptychoparia wisconsinensis (Owen).
Anomocare pero (Walcott).

67c (=67).

Obolus matinalis.
Lingulella acutangula.
Lingulella perattenuata.

67z. Upper Cambrian: Sandstone at west base of Tatur Hill, 7 miles (11.2 km.) northwest of Burnet, Burnet County, Tex. (C. D. Walcott, 1884).

Obolus matinalis.
Ptychoparia burnetensis Walcott.

68 (=68e, 68y, and 68z). Upper Cambrian: Interbedded sandstone and limestone, Packsaddle Mountain, Llano County, Tex. (C. D. Walcott, 1884).

Obolus matinalis.
Obolus tetonensis ninus.
Lingulella acutangula.
Acrotreta microscopica.
Billingsella coloradoensis.
Eoorthis indianola?.
Eoorthis remnicha texana.
Eoorthis wichitaensis.
Eoorthis wichitaensis lævisculus.
*Huenella texana.
Platyceras texanum Walcott.
Ptychoparia affinis (Walcott).
Ptychoparia diademata (Hall).
Ptychoparia llanoensis Walcott.
Ptychoparia similis Walcott.
Ptychoparia? urania Walcott.
Agraulos convexus Whitfield.
Anomocare pero (Walcott).
Chariocephalus sp.

68e (=68).

Lingulella acutangula.
Acrotreta microscopica.
Billingsella coloradoensis.

68y (=68).

Obolus sinoe.
Lingulella perattenuata.

68z (=68).

Obolus matinalis.

69. Upper Cambrian: Limestone near Honey Creek, Burnet County, Tex. (C. D. Walcott, 1884).

Obolus sinoe.
Lingulella acutangula.
Lingulella texana.
Lingulella (Lingulepis) acuminata.
Acrotreta microscopica.
Billingsella coloradoensis.
*Syntrophia alata.
Huenella texana.
Huenella texana lævisculus.
Capulus sp.
Ptychoparia affinis (Walcott).
Ptychoparia diademata (Hall).
Ptychoparia llanoensis Walcott.
Anomocare pero (Walcott).
Pterocephalia sancti-sabæ Roemer.
Chariocephalus tumifrons Hall and Whitfield.

70 (=70a and 70e). Upper Cambrian: Limestone near Morgans Creek, Burnet County, Tex. (C. D. Walcott, 1884).

Obolus sinoe.
Lingulella acutangula.
Lingulella perattenuata.
*Lingulella texana.
Lingulella (Lingulepis) acuminata.
Billingsella coloradoensis.
Capulus?.
Cystidean plates.
Ptychoparia diademata (Hall)
Ptychoparia pattersoni Hall.
Ptychoparia perseus Hall var.
Ptychoparia romerei (Shumard).
Ptychoparia suada Walcott.
Ptychoparia wisconsinensis (Owen).
Agraulos convexus Whitfield.
Anomocare pero (Walcott).
Pterocephalia sancti-sabæ Roemer.
Chariocephalus tumifrons Hall and Whitfield.
Ptychaspis granulosa (Owen).

70a (=70).

Billingsella coloradoensis.
Illænurus? dia Walcott.
Ptychoparia occidens Walcott.
Ptychoparia wisconsinensis (Owen).
Dikellocephalus belli Billings.
Dikellocephalus minnesotensis Owen.

70e (=70).

Lingulella acutangula.
*Acrotreta microscopica.
Billingsella coloradoensis.

71. Upper Cambrian: Limestone in Cold Creek Canyon, Burnet County, Tex. (C. D. Walcott, 1884).

Obolus matinalis.
Obolus sinoe.
Acrotreta microscopica.
Billingsella coloradoensis.
Eoorthis iddingsi.
Eoorthis indianola.
*Eoorthis remnicha texana.
Eoorthis wichitaensis.
Huenella texana.
*Huenella texana læviusculus.
Ptychoparia affinis (Walcott).
Ptychoparia wisconsinensis (Owen).
Agraulos convexus Whitfield.
Anomocare pero (Walcott).

72 (same horizon as 72a). Lower Cambrian: Limestone 5 miles (8 km.) east of Albany, Rensselaer County, N. Y. (C. D. Walcott and T. N. Dale, 1893).

Obolus prindlei.

72a (same horizon as 72). Lower Cambrian: Limestone 1 mile (1.6 km.) southwest of Wynantskill, Rensselaer County, N. Y. (L. M. Prindle, 1893).

*Obolus prindlei.

73. Middle Cambrian: Sandstones of the Tonto group in Kwagunt Valley, Grand Canyon of the Colorado, Ariz. (C. D. Walcott, 1882).

Obolus (Westonia) chuarensis.
*Lingulella lineolata.

73a. Middle Cambrian: "Tonto" sandstone in Chuar Valley, Grand Canyon of the Colorado, Ariz. (C. D. Walcott, 1882).

*Micromitra (Paterina) superba.
Micromitra (Iphidella) pannula.
*Obolus (Westonia) chuarensis.
Lingulella lineolata.

73b. Middle Cambrian: Sandstone in upper part of the Tonto group, lower portion of Kwagunt Valley, Grand Canyon of the Colorado, Ariz. (C. D. Walcott, 1882).

Micromitra (Paterina) crenistria.

74. Middle Cambrian: Sandstone about 300 feet (91.4 m.) above the base of the Tonto group at the head of Nunkoweap Valley, Grand Canyon of the Colorado, Ariz. (C. D. Walcott, 1882).

Micromitra pealei.
*Micromitra (Paterina) crenistria.
Micromitra (Paterina) superba.
Micromitra (Iphidella) pannula.
*Obolus zetus.
Obolus (Westonia) chuarensis.
*Obolus (Westonia) euglyphus.
Lingulella lineolata.
Lingulella perattenuata.
*Billingsella obscura.

74b. Middle Cambrian: Sandstone 1,000 feet (305 m.) above the base of the Tonto group, Nunkoweap Valley, Grand Canyon of the Colorado, Ariz. (C. D. Walcott).

Obolus (Westonia) chuarensis.

74c. Middle Cambrian: "Tonto" sandstone at the head of Lava Canyon, Grand Canyon of the Colorado, Ariz. (C. D. Walcott, 1883).

Obolus (Westonia) euglyphus.

74d. Middle Cambrian: Sandstone beds in "Tonto" shale just above massive sandstones, near mouth of Bass Canyon, on the south side of the Grand Canyon of the Colorado, southeast of Powells Plateau, Ariz. (C. D. Walcott, 1901).

Micromitra (Paterina) superba.
Micromitra (Iphidella) pannula.
Lingulella lineolata.
Lingulella perattenuata.
*Lingulella (Lingulepis) spatula.

75. Upper Cambrian: Thin-bedded limestones below the base of the Ordovician in the Tonto group, near the water's edge at the mouth of Kanab Canyon, Grand Canyon of the Colorado, Ariz. (C. D. Walcott, 1879).

Obolus zetus.
Lingulella winona convexa.
*Nisusia? (Jamesella?) kanabensis.
*Protorthis sp. undt.
} These species may not occur in the same bed.

76. Upper Cambrian: Arenaceous limestone at Hoyt's quarry, 4 miles (6.4 km.) west of Saratoga Springs, Saratoga County, N. Y. (C. D. Walcott and Cooper Curtice, 1883).

Lingulella (Lingulepis) acuminata.
Dikellocephalus.

76a. Upper Cambrian: Arenaceous limestone in a railroad quarry 1 mile (1.6 km.) north of Saratoga Springs, Saratoga County, N. Y. (C. D. Walcott and Cooper Curtice, 1883).

Lingulella (Lingulepis) acuminata.

77. Upper Cambrian: Sandstone near the water below the falls at the high bridge, and also at several horizons in the section, the highest point being 70 to 75 feet (21 to 22 m.) above the water, in Ausable Chasm, Essex County, N. Y. (C. D. Walcott and Cooper Curtice, 1883 and 1886).

*Lingulella prima.
Lingulella (Lingulepis) acuminata.

78 (=78s). Upper Cambrian: "St. Croix sandstone," quarry near St. Croix River, in suburbs of Osceola, Polk County, Wis. (L. C. Wooster, 1883).

Obolus (Westonia) aurora.
Lingulella mosia.
*Lingulella mosia osceola.
Lingulella winona.
*Lingulella winona convexa.
Billingsella coloradoensis.
Finkelnburgia finkelnburgi.
*Finkelnburgia osceola.
*Finkelnburgia osceola corrugata.
Syntrophia barabuensis.
Illænurus quadratus Hall.
Spirodentalium osceola Walcott.
Bellerophon antiquatus Whitfield.

78a. Upper Cambrian: "St. Croix sandstone" in the topmost quarry on Mount Washington, near Eau Claire, Eau Claire County, Wis. (L. C. Wooster, 1883).

Obolus sp. undt.
Dicellomus pectenoides.
Dicellomus politus.
*Agraulos? thea Walcott.
Crepicephalus iowensis (Hall).

78b. Upper Cambrian: "St. Croix sandstone" 50 feet (15.2 m.) above St. Croix River, near the landing at Osceola, Polk County, Wis. (Cooper Curtice, 1884).

Lingulella mosia.
Lingulella similis.
Finkelnburgia osceola.

78c. Upper Cambrian: "St. Croix sandstone" at Osceola, Polk County, Wis. (C. Schuchert, 1893).

Obolus (Westonia) aurora.
Lingulella oweni.
Lingulella winona.
Lingulella winona convexa.

78d. Upper Cambrian: The upper portion of the "St. Croix sandstone" exposed in the bluffs at La Crosse, La Crosse County, Wis. (C. D. Walcott, 1898).

Obolus matinalis.

78s (=78). (C. Schuchert, 1893.)

Obolus (Westonia) aurora.
Lingulella mosia.
Lingulella mosia osceola.
Lingulella winona convexa.
Finkelnburgia finkelnburgi.
Finkelnburgia osceola.
Finkelnburgia osceola corrugata.

79. Upper Cambrian: "St. Croix sandstone" in bluff near Hudson, St. Croix County, Wis. (L. C. Wooster, 1883).

Obolus matinalis.
*Obolus mickwitzi.
Obolus (Westonia) aurora.
Lingulella mosia.
Lingulella winona.
Lingulella winona convexa.
Lingulella (Lingulepis) acuminata.
Billingsella coloradoensis.
Ptychoparia wiscousinensis (Owen).

79′ (=79, though from a slightly different horizon). (Chas. Schuchert, 1893.)

Obolus matinalis.
Obolus mickwitzi.

79a. Upper Cambrian: "St. Croix sandstone," quarry and ledge 0.5 mile (0.8 km.) southeast of the county courthouse, Menomonie, Dunn County, Wis. (L. C. Wooster, 1883).

Lingulella winona convexa.
*Protorthis lævis.
Billingsella coloradoensis.
Eoorthis sp.
Finkelnburgia osceola.

79b. Upper Cambrian: "St. Croix sandstone" in shaly beds 4 feet (1.2 m.) above the water, near Hudson, St. Croix County, Wis. (J. F. James, 1889).

Obolus matinalis.
Obolus mickwitzi.
Lingulella (Lingulepis) acuminata.
Finkelnburgia osceola.

79s. Upper Cambrian: "St. Croix sandstone" in bluff near Hudson, St. Croix County, Wis. (C. Schuchert, 1893).

Lingulella mosia.
Dicellomus politus.

79x. Middle Cambrian: "St. Croix sandstone" near the flour mill on Beaver Creek, north of Galesville, Trempealeau County, Wis. (Cooper Curtice, 1882; L. C. Wooster, 1883). (See p. 159.)

Lingulella (Lingulepis) acuminata.
Dicellomus politus.

80. Upper Cambrian: "St. Croix sandstone" 0.66 mile (1.1 km.) southwest of the railway depot, Menomonie, Dunn County, Wis. (L. C. Wooster, 1883).

Lingulella ampla.
Lingulella winona convexa.
Dicellomus politus.
Finkelnburgia osceola.

80a. Upper Cambrian: "St. Croix sandstone" 4 miles (6.4 km.) north of Reedsburg, Sauk County, Wis. (L. C. Wooster, 1883).

Lingulella similis.
Billingsella coloradoensis.
*Eoorthis remnicha.
Eoorthis remnicha sulcata.
Finkelnburgia osceola.

81. Upper Cambrian: "St. Croix sandstone" 1 mile (1.6 km.) east-northeast of Devils Lake, Sauk County, Wis. (L. C. Wooster, 1883).

Finkelnburgia finkelnburgi.

81b. Upper Cambrian: "St. Croix sandstone" near Devils Lake, Sauk County, Wis. (Cooper Curtice, 1884).

Obolus (Westonia) stoneanus.
*Eoorthis diablo.
Finkelnburgia finkelnburgi.
Syntrophia barabuensis.

81o. Upper Cambrian: "St. Croix sandstone" on the railroad track below the Cliff House, Devils Lake, Sauk County, Wis. (J. F. James, 1889).

Syntrophia barabuensis.

82 (see 82s). Upper Cambrian: "St. Croix sandstone" on the bank of St. Croix River, at St. Croix Falls, Polk County, Wis. (L. C. Wooster, 1883).

Lingulella (Lingulepis) acuminata.

82a. Upper Cambrian: "St. Croix sandstone" 25 feet (7.6 m.) above the water level, near the Knapp, Stout and Company's buildings, Menomonie, Dunn County, Wis.

Obolus matinalis.
Lingulella phaon.

82b (see 339d; may be same locality). Upper Cambrian: "St. Croix sandstone" along the railroad track near Taylors Falls, Chisago County, Minn. (W. A. Finkelnburg).

*Curticia elegantula.
Obolus matinalis.
Dicellomus politus

82c. Upper Cambrian: Conglomerate beds in the "St. Croix sandstone" in point below Franconia, Chisago County, Minn. (W. A. Finkelnburg).

Lingulella similis.

82s (see 82). Upper Cambrian: "St. Croix sandstone" on the bank of St. Croix River, St. Croix Falls, Polk County, Wis. (C. Schuchert, 1893).

Obolus matinalis.
Lingulella (Lingulepis) acuminata.

83. Upper Cambrian: "St. Croix sandstone" near Trempealeau, Trempealeau County, Wis. (Cooper Curtice and G. H. Squiers, 1884).

Obolus matinalis.
Dicellomus politus.
Eoorthis diablo.
*Finkelnburgia finkelnburgi.
Finkelnburgia osceola.
Syntrophia barabuensis.
Chariocephalus whitfieldi Hall.

83[1] (=135c). (Chas. Schuchert, 1893.)

Billingsella coloradoensis.
Finkelnburgia finkelnburgi.
Finkelnburgia osceola.

83[3]. Upper Cambrian: Green-sand horizon in the "St. Croix sandstone," below the "fifth trilobite bed" of Owen, at Trempealeau, Trempealeau County, Wis. (Chas. Schuchert, 1893).

Billingsella coloradoensis.
Chariocephalus whitfieldi Hall.

83[4]. Middle Cambrian: "St. Croix sandstone," in beds characterized by the presence of *Crepicephalus iowensis*, at Trempealeau, Trempealeau County, Wis. (C. Schuchert, 1893). (See p. 159.)

Obolus matinalis.

84. Middle Cambrian: "St. Croix sandstone" at Dresbach, opposite the mouth of Black River, Winona County, Minn. (Cooper Curtice, 1884). (See p. 159.)

Obolus namouna.
Obolus rhea.
Lingulella ampla.
Lingulella (Lingulepis) acuminata.
Dicellomus politus.

84a. Upper Cambrian: "St. Croix sandstone," River Junction, Houston County, 20 miles (32.2 km.) below Dresbach, Minn. (Cooper Curtice, 1884).

Lingulella phaon.[a]
Billingsella coloradoensis.
Syntrophia primordialis.
Dikellocephalus misa Hall.
Chariocephalus whitfieldi Hall.

84f. Middle Cambrian: "St. Croix sandstone" at Dresbach, opposite the mouth of Black River, Winona County, Minn. (W. A. Finkelnburg, 1897). (See p. 159.)

Lingulella ampla.
Dicellomus politus.

84s. Middle Cambrian: "St. Croix sandstone" near Dakota, Winona County, Minn. (Chas. Schuchert, 1893). (See p. 159.)

Lingulella ampla.
Lingulella (Lingulepis) acuminata.
Dicellomus politus.

85 (=85s). Upper Cambrian: "St. Croix sandstone" at Prairie du Sac, Sauk County, Wis. (Cooper Curtice, 1884).

Obolus (Westonia) stoneanus.
*Lingulella mosia.

85a. Upper Cambrian: "St. Croix sandstone" at Brown's quarry, Prairie du Sac, Sauk County, Wis. (Cooper Curtice, 1884).

Lingulella oweni.

85s (=85, though possibly from a slightly different bed). Upper Cambrian: "St. Croix sandstone" at Prairie du Sac, Sauk County, Wis. (Chas. Schuchert, 1893).

Obolus (Westonia) aurora.
*Obolus (Westonia) stoneanus.
Lingulella mosia.
Lingulella oweni.
Lingulella winona.
Lingulella winona convexa.
Illænurus quadratus Hall.
Dikellocephalus minnesotensis Owen.
Dikellocephalus pepinensis Owen.

[a] May be from a horizon different from that of the other species.

85x. Upper Cambrian: Upper beds of the "St. Croix sandstone" near Mazomanie, Dane County, Wis. (Chas. Schuchert, 1893).

Obolus (Westonia) stoneanus.
Lingulella mosia.
Lingulella winona.
Lingulella winona convexa.
Finkelnburgia osceola.
Dikellocephalus sp.

S85x (=85x, though possibly from a slightly different bed).

*Obolus (Westonia) aurora.
Lingulella mosia.
Lingulella winona convexa.

85z. Upper Cambrian: "St. Croix sandstone" at Madison, Dane County, Wis. (L. C. Wooster, 1883; Cooper Curtice, 1884; and J. James, 1889).

Lingulella oweni.

86. Upper Cambrian: "St. Croix sandstone" at Van Ness quarry, Gibraltar Bluff, Lodi, Columbia County, Wis. (L. C. Wooster, 1883; Cooper Curtice, 1884).

Obolus (Westonia) aurora.
Lingulella mosia.
*Lingulella oweni.

86a. Upper Cambrian: "St. Croix sandstone" near Red Wing, Goodhue County, Minn. (Cooper Curtice, 1884).

Lingulella similis.
Billingsella coloradoensis.
*Otusia sandbergi.
*Eoorthis remnicha.[a]

87. Lower Cambrian: Limestone 1 mile (1.6 km.) south-southwest of Highgate Falls, Franklin County, Vt. (C. D. Walcott, 1885).

Micromitra (Paterina) labradorica swantonensis.
Obolus? sp. undt.
*Lingulella franklinensis.

87′. Upper Cambrian: Limestone 1 mile (1.6 km.) south-southwest of Highgate Falls, Franklin County, Vt.

*Obolus sp. undt. d.

This species is labeled as coming from locality No. 87, but horizon is given as Upper Cambrian instead of Lower Cambrian.

88a. Middle Cambrian: Limestone about 100 feet (30.5 m.) above the quartzitic sandstone at the base of the Cambrian, in the northern suburbs of Deadwood, in the Black Hills, South Dakota (C. D. Walcott, 1887).

Lingulella ampla.
Lingulella desiderata.
*Lingulella similis.
*Linnarssonella girtyi.
Acrotreta idahoensis.
Ptychoparia vacuna Walcott.
Liostracus panope (Walcott).

89. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone in Murphrees Valley, Blount County, Ala. (A. M. Gibson, 1884).

Lingulella (Lingulepis) acuminata.
*Dicellomus appalachia.

90. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Conasauga ("Coosa") shale on Edward's farm, near Craigs Mountain, about 10 miles (16.1 km.) southeast of Center, Cherokee County, Ala. (Cooper Curtice, 1885).

Micromitra (Paterina) major.
Obolus (Westonia) ella.
Lingulella similis?.
Acrotreta kutorgai.
*Wimanella? anomala.
Olenoides curticei Walcott.
Olenoides sp.

90a. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales at Cedar Bluff, Cherokee County, Ala. (Bufford, 1892).

Dicellomus appalachia.

90b. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Conasauga limestone in cut on Louisville and Nashville Railroad, near Woodstock, Bibb County, Ala. (Chas. Butts, 1904).

Lingulella buttsi.
Lingulella desiderata.
Dicellomus appalachia.
Acrotreta kutorgai.
Agnostus.
Ptychoparia.

90c. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Conasauga limestone near Kimbrel, Bibb County, Ala. (Chas. Butts, 1904).

*Lingulella buttsi.

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[a] Winchell [1886, p. 317] gives the type locality as St. Croix sandstone in sewer excavations at the corner of Brush and Main streets, Red Wing, Minn.

90x (=94a). (For stratigraphic position and association, see p. 147.) Middle Cambrian: In and attached to the outer surface of siliceous nodules in the Conasauga ("Coosa") shale, Coosa Valley, east of Center, Cherokee County, Ala. (A. M. Gibson, 1884, and Cooper Curtice, 1885).

Micromitra alabamaensis.
*Lingulella hayesi.
*Acrothele bellula.
*Acrotreta kutorgai.
Ptychoparia.
Anomocare.
Olenoides curticei Walcott.
Laotira cambria Walcott.
Brooksella alternata Walcott.

91. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Conasauga ("Coosa") shale at Cedar Bluff, Cherokee County, Ala. (A. M. Gibson, 1884, and Cooper Curtice, 1885).

Obolus willisi.
Lingulella nanno.
*Lingulella quadrilateralis.
Dicellomus appalachia.

92b (the specimens are labeled 1092b). Upper Cambrian: Limestone on Buffalo Creek, 2 miles (3.2 km.) southeast of Buffalo Mills, Rockbridge County, Va. (C. D. Walcott, 1898).

Obolus matinalis.
Lingulella (Lingulepis) acuminata.

92x. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Conasauga ("Coosa") shale at Yanceys Bend, Coosa River, southeast of Center, Cherokee County, Ala. (Cooper Curtice, 1885).

Obolus sinoe.
Lingulella similis?.

93. (For stratigraphic position and association, see p. 147.) Upper Cambrian: Shales and limestones at the base of the Knox dolomite near Jordan's, just below the ford on Cowan Creek, about 8 miles (12.8 km.) southeast of Center, Cherokee County, Ala. (Cooper Curtice, 1885).

Obolus willisi.
Lingulella desiderata.

93a. (For stratigraphic position and association, see p. 147.) Upper Cambrian: Shales and limestones at the base of the Knox dolomite on Terrapin Creek road from Center to Amberson, Cherokee County, Ala. (Cooper Curtice, 1885).

Lingulella desiderata?.

93n (16 of section). (For stratigraphic position and association, see p. 147.) Upper Cambrian: Shales in the southern part of Jordan's farm, near Jordan's crossroads, about 8 miles southeast of Center, Cherokee County, Ala. (Cooper Curtice, 1885).

Obolus willisi.

93o (=93). (For stratigraphic position and association, see p. 147.) (Cooper Curtice, 1885.)

Lingulella desiderata.

93x. (For stratigraphic position and association, see p. 147.) Upper Cambrian: Shales on the Clarke farm, near the ford across Cowan Creek, about 2 miles (3.2 km.) north of Jordan's crossroads, southeast of Center, Cherokee County, Ala. (Cooper Curtice, 1885).

Obolus willisi.

94 (see 94a, 94o, 94x, and 94xx; 8½ of section). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales 0.25 mile (0.4 km.) beyond Steel Ford, Cowan Creek, about 8 miles (12.8 km.) southeast of Center, Cherokee County, Ala. (Cooper Curtice, 1885).

*Micromitra alabamaensis.
Obolus willisi.

94a (=shales in which nodules of 90x are embedded; see 94, 94o, 94x, and 94xx; 9 of section). (For stratigraphic position and association, see p. 147.) (Cooper Curtice, 1885.)

Micromitra alabamaensis.
Obolus willisi.
Lingulella hayesi.

94o (see 94, 94a, 94x, and 94xx; 12 of section). (For stratigraphic position and association, see p. 147.) Upper Cambrian: Limestone at base of dolomite 0.25 mile (0.4 km.) beyond Givens Ford, Cowan Creek, about 8 miles (12.8 km.) southeast of Center, Cherokee County, Ala. (Cooper Curtice, 1885).

Micromitra alabamaensis.
Lingulella desiderata.
Acrotreta sp.

94x (see 94, 94a, 94o, and 94xx). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales 0.06 mile (0.1 km.) south of Givens mill, Cowan Creek, about 8 miles (12.8 km.) southeast of Center, Cherokee County, Ala. (Cooper Curtice, 1885).

Acrothele bellula.

94xx (see 94, 94a, 94o, and 94x; 10 of section). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone at base of dolomite at Givens mill, Cowan Creek, about 8 miles (12.8 km.) southeast of Center, Cherokee County, Ala. (Cooper Curtice, 1885).

Lingulella desiderata.
Acrotreta sp.

95a. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales on Spring Creek, near old tram crossing north of the Center road, Cowan Creek valley, southeast of Center, Cherokee County, Ala. (Cooper Curtice, 1885).

Micromitra alabamaensis.

96. (For stratigraphic position and association, see p. 147.) Upper Cambrian: Limestone near the ford on the Cedartown road, 1.5 miles (2.4 km.) south of Rome, Floyd County, Ga. (Cooper Curtice, 1885).

Micromitra (Iphidella) pannula.
Obolus rotundatus.
Lingulella desiderata.
*Lingulella leos.

96b. (For stratigraphic position and association, see p. 147.) Upper Cambrian: Shales in a railroad cut on the Southern Railway, near Cave Spring, 10 miles (16.1 km.) southwest of Rome, Floyd County, Ga. (Cooper Curtice, 1885).

Obolus willisi.

96x. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone 1 mile (1.6 km.) north of Adairsville, 15 miles (24.2 km.) northwest of Cartersville, Cartersville quadrangle (U. S. G. S.), Bartow County, Ga. (Cooper Curtice, 1885).

*Acrotreta concentrica.

97 (=97x and S97x, though possibly from a slightly different horizon). Upper Cambrian: "St. Croix sandstone" at Reads Landing, foot of Lake Pepin, Wabasha County, Minn. (Cooper Curtice, 1884).

Obolus (Westonia) aurora.
Lingulella oweni.
Lingulella similis.
Dicellomus politus.
Billingsella coloradoensis.
Eoorthis sp.
*Syntrophia primordialis argia.

97a. Upper Cambrian: "St. Croix sandstone" near Winfield, Jefferson County, Wis. (Cooper Curtice, 1884).

Lingulella similis.
Lingulella (Lingulepis) acuminata.
Billingsella coloradoensis.
Eoorthis remnicha.
Eoorthis remnicha sulcata.
*Eoorthis remnicha winfieldensis.
Eoorthis sp.

97b. Upper Cambriau: In the "St. Croix sandstone" below the green-sand bed and about 25 feet (7.6 m.) above St. Croix River, at Franconia, Chisago County, Minn. (Cooper Curtice, 1884).

Obolus matinalis.
Lingulella (Lingulepis) acuminata.
Billingsella coloradoensis.

97c. Upper Cambrian: "St. Croix sandstone" at Winfield, Jefferson County, Wis. (Cooper Curtice, 1884).

Lingulella similis.

97s. Upper Cambrian: "St. Croix sandstone" at Franconia, Chisago County, Minn. (Chas. Schuchert, 1893).

Lingulella similis.

97x (=97, though possibly from a slightly different horizon). (Chas. Schuchert, 1893.)

Eoorthis remnicha sulcata.

S97x (=97, though possibly from a slightly different horizon). (Chas. Schuchert, 1893.)

Dicellomus politus.
Billingsella coloradoensis.

98 (=98x, though from a slightly different horizon). Upper Cambrian: "St. Croix sandstone" near Eau Claire Eau Claire County, Wis. (Cooper Curtice, 1884).

Obolus matinalis.
*Obolus namouna.
*Obolus rhea.
Lingulella ampla.
Lingulella mosia osceola.
Lingulella phaon.
Lingulella (Lingulepis) acuminata.
Dicellomus politus.
Ptychoparia onustus (Whitfield).
Hyolithes.

98a. Upper Cambrian: "St. Croix sandstone" at Marine Mills, on St. Croix River, Washington County, Minn.

Lingulella mosia.
Dicellomus politus.
Billingsella coloradoensis.
Ptychoparia sp.
Ptychaspis granulosa (Owen).

98x (=98, though from a slightly different horizon). (Cooper Curtice, 1884.)

Obolus matinalis.
Lingulella mosia.
*Lingulella phaon.
Dicellomus politus.

99. Upper Cambrian: "St. Croix sandstone" at Minneiska (Miniska), on Mississippi River, near the line between Wabasha and Winona counties, Minn. (Cooper Curtice, 1884).

Syntrophia primordialis.

99a. Upper Cambrian: "St. Croix sandstone" near Pilot Knob, Adams County, Wis. (Cooper Curtice, 1884).

Lingulella mosia.
Lingulella (Lingulepis) acuminata.
Eoorthis remnicha winfieldensis.

100. Upper Cambrian: "St. Croix sandstone" near Menomonie, Dunn County, Wis. (Cooper Curtice, 1884).

Obolus matinalis.
Obolus sp. undt.
Lingulella ampla.
Lingulella mosia.
Lingulella winona convexa.
Dicellomus pectenoides.
Dicellomus politus.
Billingsella coloradoensis.

100a. Upper Cambrian: "St. Croix sandstone" at Ettrick, Trempealeau County, Wis. (Cooper Curtice, 1884).

Dicellomus politus.

101 (25 feet above 101a; same horizon as 102). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Rogersville shale just above the road in the hill west of the schoolhouse 3.5 miles (5.6 km.) southwest of Rogersville, on the road to Melinda Ferry [see Keith, 1896a, areal geology sheet], Hawkins County, Tenn. (R. R. Gurley, 1887).

Micromitra (Iphidella) pannula.
Obolus lamborni minimus.

101a (25 feet below 101). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Rogersville shale just above the road in the hill west of the schoolhouse 3.5 miles (5.6 km.) southwest of Rogersville, on the road to Melinda Ferry [see Keith, 1896a, areal geology sheet], Hawkins County, Tenn. (R. R. Gurley, 1887).

*Obolus lamborni minimus.
Lingulella desiderata.
*Acrotreta rudis.

101b. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Rogersville shale just east of the schoolhouse 3.5 miles (5.6 km.) southwest of Rogersville, on the road to Melinda Ferry [see Keith, 1896a, areal geology sheet], Hawkins County, Tenn. (R. R. Gurley, 1887).

Obolus lamborni.
Obolus willisi.
Lingulella desiderata.

102 (same horizon as 101). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Rogersville shale just south of road 0.5 mile (0.8 km.) southwest of Rogersville, on the road to Melinda Ferry [see Keith, 1896a, areal geology sheet], Hawkins County, Tenn. (R. R. Gurley, 1887).

Obolus lamborni.
Dicellomus appalachia.

102c. (For stratigraphic position and association, see p. 147.) Middle Cambrian: First shale south of the Estillville pike, 3.5 miles (5.6 km.) east of Rogersville, Greeneville quadrangle (U. S. G. S.), Hawkins County, Tenn. (R. R. Gurley, 1887).

Acrotreta rudis.

103 (below 103a). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Second shale south of the ridge of sandstone in the Rome formation ("Town Knobs"), on the road from Rogersville to Dodson Ford, near the line between the Morristown and Greeneville quadrangles (U. S. G. S.), Hawkins County, Tenn. (R. R. Gurley, 1887).

Obolus lamborni.

103a (immediately underlying 103b). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Upper part of the second shale south of the ridge of sandstone in the Rome formation ("Town Knobs"), on the road from Rogersville to Dodson Ford, near the line between the Morristown and Greeneville quadrangles (U. S. G. S.), Hawkins County, Tenn. (R. R. Gurley, 1887).

Obolus lamborni minimus.
Dicellomus appalachia.

103b (immediately overlying 103a). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Third limestone (100 yards (90 m.) down the road toward the river from 103a) south of the ridge of sandstone in the Rome formation ("Town Knobs"), on the road from Rogersville to Dodson Ford, near the line between the Morristown and Greeneville quadrangles (U. S. G. S.), Hawkins County, Tenn. (R. R. Gurley, 1887).

Lingulella desiderata.

104. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shale in railroad cut 0.5 mile (0.8 km.) from Rogersville, on the road to Holston River, near the line between the Morristown and Greeneville quadrangles (U. S. G. S.), Hawkins County, Tenn. (R. R. Gurley, 1887).

Dicellomus appalachia.

105. (For stratigraphic position and association, see p. 147.) Upper Cambrian: Limestone in Knox dolomite at Bishops mill, Hancock County, Tenn. (Ira Sayles, 1884).

Lingulella (Lingulepis) acuminata.

105t. (For stratigraphic position and association, see p. 153.) Lower Ordovician: Thin-bedded bluish-gray limestone [Walcott, 1908f, p. 173, and Pls. XIII and XIV], at the summit of Notch Peak, House Range, Millard County, Utah (C. D. Walcott, F. B. Weeks, and L. D. Burling, 1905).

*Obolus (Westonia) notchensis.
Eoorthis desmopleura.
Raphistoma sp.

105x. (For stratigraphic position and association, see p. 148.) Middle Ordovician: Gray siliceous shales just below a band of quartzitic sandstones probably corresponding in position to the upper part of the Simpson formation of the Oklahoma section, in Wasatch Canyon, east of Lakeview ranch, about 5 miles (8 km.) north of Brigham, Boxelder County, Utah (F. B. Weeks and L. D. Burling, 1905).

*Obolus (Westonia) elongatus.

106. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales of the Rome formation on the roadside at the eastern base of Shooks Gap, in Bays Mountains, 10 miles (16.1 km.) southeast of Knoxville [see Keith, 1895, areal geology sheet], Knox County, Tenn. (Cooper Curtice, 1885).

Lingulella similis.

106a. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Reddish-brown shales in middle of valley east of Shooks Ridge, in Bays Mountains, 10 miles (16.1 km.) southeast of Knoxville, Knox County, Tenn. (Cooper Curtice, 1885).

Obolus willisi.

107 (just above 107a). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone in Bull Run, northwest of Copper Ridge [Keith, 1896b, areal geology sheet], 11 miles (17.6 km.) northwest of Knoxville, Knox County, Tenn. (Cooper Curtice, 1885).

Dicellomus appalachia.
Wimanella harlanensis.

107a (just below 107, above 107b). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales in railroad cut in Bull Run, northwest of Copper Ridge [Keith, 1896b, areal geology sheet], 11 miles (17.6 km.) northwest of Knoxville, Knox County, Tenn. (Cooper Curtice, 1885).

Obolus willisi.
Lingulella desiderata ?.

107b (below 107a). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales and sandstones of the Rome formation in railroad cut in Bull Run, northwest of Copper Ridge [Keith, 1896b, areal geology sheet], 11 miles (17.6 km.) northwest of Knoxville, Knox County, Tenn. (Cooper Curtice, 1885).

Obolus willisi.
Lingulella?.
Dicellomus appalachia.
Linnarssonella tennesseensis.

107o (just above 107u). (For stratigraphic position and association, see p. 147.) Upper Cambrian: Limestones and shales at the base of the Knox dolomite west of the top of Copper Ridge, near the Southern Railway cut, about 10 miles (16.1 km.) northwest of Knoxville [see Keith, 1896b, areal geology sheet], Knox County, Tenn. (Cooper Curtice, 1885).

Lingulella desiderata.
Lingulella (Lingulepis) acuminata.
Acrotreta kutorgai.

107u (just below 107o). (For stratigraphic position and association, see p. 147.) Upper Cambrian: Limestones and shales at the base of the Knox dolomite west of the top of Copper Ridge, near the Southern Railway cut, about 10 miles (16.1 km.) northwest of Knoxville [see Keith, 1896b, areal geology sheet], Knox County, Tenn. (Cooper Curtice, 1885).

Lingulella desiderata?.
Acrotreta kutorgai.

108. Upper Cambrian: Sandstone 1 mile (1.6 km.) south of Poughkeepsie, Dutchess County, N. Y. (C. D. Walcott, 1886).

Lingulella (Lingulepis) acuminata.

109 (see 367k). Upper Cambrian: Sandstone 25 feet (7.6 m.) above the Archean 1.5 miles (2.4 km.) south of Deweys Bridge, on the Champlain Canal, Washington County, N. Y. (C. D. Walcott, 1886).

Lingulella (Lingulepis) acuminata.

110 (just below 110a). Upper Cambrian: Shaly calcareous sandstone resting on massive layers of Potsdam sandstone, east side of the town of Whitehall, Washington County, N. Y. (C. D. Walcott, 1886).

Lingulella (Lingulepis) acuminata.

110a (just above 110). Upper Cambrian: Sandstone on the east side of the town of Whitehall, Washington County, N. Y. (C. D. Walcott, 1886).

Lingulella (Lingulepis) acuminata.

111. Upper Cambrian: At the top of the Potsdam sandstone on Marble River, 1 mile (1.6 km.) south of Chateaugay, Franklin County, N. Y. (C. D. Walcott, 1886).

Lingulella (Lingulepis) acuminata.

113. Upper Cambrian: "St. Croix sandstone" at La Grange Mountain (or Barn Bluff), near Red Wing, Goodhue County, Minn. (Cooper Curtice, 1884).

Lingulella mosia.
Lingulella winona.

114 (above 114a). (For stratigraphic position and association, see p. 140.) Upper Cambrian: Upper sandstone beds on Little Belle Island, Conception Bay, Newfoundland (C. D. Walcott, 1888).

Lingulella bella.
Lingulella bellula.

114a (below 114). (For stratigraphic position and association, see p. 140.) Upper Cambrian: Sandy shales underlying beds of Locality 114, Little Belle Island, Conception Bay, Newfoundland (C. D. Walcott, 1888).

Lingulella bella.
*Lingulella bellula.

114b. (For stratigraphic position and association, see p. 140.) Lower Ordovician: Sandstone 1 mile (1.6 km.) north of Lance Cove, Great Belle Island, Conception Bay, Newfoundland (C. D. Walcott, 1888).

*Obolus (Lingulobolus) affinis.
*Obolus (Lingulobolus) spissus.
Obolus (Westonia) rogersi.
*Lingulella bella.

116. Upper Cambrian: "St. Croix sandstone" in excavation on Wells farm, 2 miles (3.2 km.) west of Baraboo, Baraboo quadrangle (U. S. G. S.), Sauk County, Wis.

*Billingsella major.

117. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales on the road north from Greeneville, Greene County, Tenn. (Cooper Curtice, 1886).

Lingulella desiderata.

117c. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shale at Buckingham Ford on Hollis Creek, 5 miles (8 km.) southeast of Greeneville, Greene County, Tenn. (Cooper Curtice, 1886).

Dicellomus appalachia.

118 (same horizon as 117c). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales on the Tazewell road, 2 miles (3.2 km.) north of Knoxville, Knox County, Tenn. (M. R. Campbell, 1891).
Obolus lamborni minimus.

119. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone in various localities in Jefferson and Hawkins counties, Tenn. (Ira Sayles, 1885).
Dicellomus appalachia.

121. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Rogersville shale, road just east of Harlan Knob, 4 miles (6.4 km.) northeast of Rogersville [see Keith, 1905, areal geology sheet], Hawkins County, Tenn. (C. D. Walcott, 1891).
Micromitra alabamaensis.
Obolus lamborni.
Obolus willisi.
Lingulella desiderata.
Acrotreta rudis.
*Billingsella? appalachia.
*Wimanella harlanensis.

121a (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales on road leading from southeast of Harlan Knob to Amis post office, about 4 miles (6.4 km.) northeast of Rogersville [see Keith, 1905, areal geology sheet], Hawkins County, Tenn. (C. D. Walcott, 1891).
Micromitra alabamaensis.

122. (For stratigraphic position and association, see p. 147.) Upper Cambrian: Shale southwest of "Town Knobs",[a] 1 mile (1.6 km.) southwest of Rogersville, Hawkins County, Tenn. (C. D. Walcott, 1891).
Obolus willisi.
Lingulella desiderata.

122a. (For stratigraphic position and association, see p. 147.) Upper Cambrian: Shale at the headwaters of Forgey Creek, northwestern part of the Greeneville quadrangle (U. S. G. S.), Hawkins County, Tenn. (C. D. Walcott, 1891).
Obolus lamborni.
Lingulella desiderata.

123. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Upper part of Maryville limestone on Big Creek, southeast of Harlan Knob, 4 miles (6.4 km.) northeast of Rogersville [see Keith, 1905, p. 4, and areal geology sheet], Hawkins County, Tenn. (C. D. Walcott, 1891).
Micromitra alabamaeusis.
Ptychoparia.

124 (=124a). (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales (Nolichucky?) overlying the limestone which rests on the Rogersville shale on Big Creek, southeast of Harlan Knob, 4 miles (6.4 km.) northeast of Rogersville [see Keith, 1905, p. 4, and areal geology sheet], Hawkins County, Tenn. (C. D. Walcott, 1891).
Micromitra alabamaensis.
Obolus lamborni minimus.

124a (=124). (For stratigraphic position and association, see p. 147.) (C. D. Walcott, 1891.)
Obolus lamborni.
Lingulella (Lingulepis) acuminata.
Dicellomus appalachia.

128. (For stratigraphic position and association, see p. 147.) Upper Cambrian: Shale 1.5 miles (2.4 km.) southwest of Cleveland, Bradley County, Tenn. (C. D. Walcott, 1891).
Lingulella?.

128a. (For stratigraphic position and association, see p. 147.) Upper Cambrian: Shales on the Louisville and Nashville Railroad, 1.5 miles (2.4 km.) southeast of Cog Hill, near the line between Polk and McMinn counties, Tenn. (M. R. Campbell, 1891).
Lingulella sp.
Dicellomus politus.

131. Upper Cambrian: Sandstone in a cut on the Chicago, Milwaukee and St. Paul Railway, 4 miles (6.4 km.) southeast of Lake City, Wabasha County, Minn. (C. Schuchert, 1893).
Billingsella coloradoensis.

134. Upper Cambrian: "St. Croix sandstone" in the lowest beds exposed along the banks of Red Cedar River, opposite Menomonie, Dunn County, Wis. (C. Schuchert, 1893).
Obolus matinalis.

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[a] See localities **103, 103a,** and **103b,** pp. 220–221.

134a. Upper Cambrian: "St. Croix sandstone" in a quarry 1 mile (1.6 km.) southeast of the county courthouse, in Menomonie, Dunn County, Wis. (C. Schuchert, 1893).
Syntrophia barabuensis.

135. Upper Cambrian: "St. Croix sandstone" near Trempealeau, Trempealeau County, Wis. (C. Schuchert, 1893).
Lingulella winona convexa.

135b. Upper Cambrian: "St. Croix sandstone" near Trempealeau, Trempealeau County, Wis. (C. Schuchert, 1893).
Finkelnburgia finkelnburgi.

135c (=83[1]). Upper Cambrian: Uppermost horizon of the "St. Croix sandstone" near Trempealeau, Trempealeau County, Wis. (C. Schuchert, 1893).
Finkelnburgia finkelnburgi.
Finkelnburgia osceola.
Dikellocephalus minnesotensis Owen.

136. Upper Cambrian: Potsdam sandstone in bank of stream opposite the first switch on the Port Henry and Maine Railroad out of Port Henry, Essex County, N. Y. (C. D. Walcott, 1889).
Lingulella prima.

137. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales on southeast side of northeast end of Cane Creek Mountains, 3 miles (4.8 km.) south of Gadsden, Etowah County, Ala. (Cooper Curtice, 1892).
Acrotreta kutorgai.

138. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shale in the street northeast of Printuf House, Gadsden, Etowah County, Ala. (Cooper Curtice, 1892).
Lingulella similis.

138a. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales in the Rome formation west of the cemetery west of Rome, Floyd County, Ga. (Cooper Curtice, 1892).
Lingulella similis.

139. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone on Hokes Bluff road north of the chert outcrop, 5 miles (8 km.) east of Gadsden, Etowah County, Ala. (Cooper Curtice, 1892).
Lingulella desiderata.

139a. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone on road near Wades Gap, near Chepultepec, Jefferson County, Ala. (Cooper Curtice, 1892).
Acrotreta kutorgai.

140. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone interbedded in shales near Chepultepec, Jefferson County, Ala. (Cooper Curtice, 1892).
Acrotreta kutorgai.

140a. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales 200 yards (182.9 m.) east of Thomas Mills, 5 miles (8 km.) north of Cave Spring [see Hayes, 1902, historical geology sheet], Floyd County, Ga. (Cooper Curtice, 1892).
Obolus lamborni.
Obolus willisi.
Lingulella quadrilateralis.

140c. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shale at edge of hill on the road leading west of Cave Spring, 10 miles (16.1 km.) southwest of Rome, Floyd County, Ga. (Cooper Curtice, 1892).
Lingulella similis.
Lingulella sp.

141a. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone 0.25 mile (0.4 km.) west of the hotel at Montevallo, Shelby County, Ala. (Cooper Curtice, 1892).
Obolus (Westonia) ella.

142. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales just above the *Olenellus* zone near the railroad 4.5 miles (7.2 km.) north of Montevallo, Shelby County, Ala. (Cooper Curtice, 1892).
Acrotreta kutorgai?.

144c. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone near the top of the beds exposed near N. K. Burns's barns, near Viola, Blount County, Ala. (Cooper Curtice, 1892).
Dicellomus appalachia.

145. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shale in bluff on Coosa River east of Turkeytown, 8 miles (12.8 km.) northeast of Gadsden, Etowah County, Ala. (Biddle and Russell, 1886).
Lingulella similis.

146. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Conasauga ("Coosa") shale on the Jacksonville road, 8 miles (12.8 km.) east of Center, Cherokee County, Ala. (Biddle, 1883).
Obolus willisi.

147a. Upper Cambrian: Limestone in Spring Hill Canyon, west side of the Bridger Range, Gallatin County, Mont. (A. C. Peale, 1885).
Billingsella coloradoensis.

148a. Upper Cambrian: Limestone of the Gallatin formation at the head of Bostwick Canyon (the name is given on the Threeforks sheet (U. S. G. S.)) [Iddings and Weed, 1894, areal geology sheet [a]], in the Bridger Range, Livingston quadrangle (U. S. G. S.), Gallatin County, Mont. (A. C. Peale, 1885).
Obolus tetonensis.

149a. Middle Cambrian: Limestone at the forks of Pole Creek, above Cherry Creek basin, Threeforks quadrangle (U. S. G. S.), Madison County, Mont. (A. C. Peale, 1887).
Micromitra (Iphidella) pannula.
*Billingsella striata.

150a. Upper Cambrian: Limestone on the east side of Dry Creek, above the mouth of Pass Creek, about 5 miles (8 km.) north of Hillsdale, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (A. C. Peale, 1885).
Billingsella plicatella.
Eoorthis wichitaensis.

151 (see 151a). Upper Cambrian: Limestone in point overlooking Churn Canyon, on the west side of the Bridger Range, Gallatin County, Mont. (A. C. Peale, 1885).
Obolus discoideus.
Billingsella plicatella.
Eoorthis wichitaensis.

151a (a little higher horizon than 151, same locality). Upper Cambrian: Limestone in point overlooking Churn Canyon, on the west side of the Bridger Range, Gallatin County, Mont. (A. C. Peale, 1885).
Dicellomus pectenoides.
Billingsella plicatella.

152. Upper Cambrian: Limestone on ridge between Churn and Cottonwood canyons, west side of Bridger Range, Gallatin County, Mont. (A. C. Peale, 1885).
Billingsella plicatella.
Eoorthis desmopleura?.

152a. Upper Cambrian: Limestone on west side of Dry Creek, below Pass Creek, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (A. C. Peale, 1885).
Dicellomus nanus.

152b. Upper Cambrian: East side of Dry Creek, below Pass Creek, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (A. C. Peale, 1885).
Obolus tetonensis?.

153 (slightly different horizon than 153a). Upper Cambrian: Limestone in ravine on west side of Dry Creek, near the mouth of Pass Creek, about 5 miles (8 km.) north of Hillsdale, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (A. C. Peale, 1885).
Billingsella plicatella.
Huenella abnormis.

153a (slightly different horizon than 153). Upper Cambrian: Limestone in ravine on west side of Dry Creek, near the mouth of Pass Creek, about 5 miles (8 km.) north of Hillsdale, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (A. C. Peale, 1885).
Eoorthis remnicha.
Eoorthis remnicha texana.
Eoorthis wichitaensis.

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[a] Iddings, J. P., and Weed, W. H., Livingston folio (No. 1), Geol. Atlas U. S., U. S. Geol. Survey, 1894.

154. Upper Cambrian: Limestone in hill on west side of Dry Creek, opposite mouth of Pass Creek, about 5 miles (8 km.) north of Hillsdale, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (A. C. Peale, 1885).

Billingsella plicatella.
Eoorthis desmopleura?.
Eoorthis remnicha.

155. Upper Cambrian: Limestone north of East Gallatin River, near Hillsdale, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (A. C. Peale, 1888).

Billingsella coloradoensis.

155a. Middle Cambrian: Limestone north of East Gallatin River, near Hillsdale, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (A. C. Peale, 1888).

*Micromitra pealei.

156a. Middle Cambrian: Limestones of the Flathead formation [Peale, 1893, p. 20], north of East Gallatin River, near Hillsdale, Gallatin County, Mont. (A. C. Peale. 1888).

Acrotreta attenuata.

156b. Upper Cambrian: Limestone north of East Gallatin River, at the north end of the Gallatin Valley, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (A. C. Peale, 1884).

Billingsella plicatella.

157 (same locality as 158 and 156, but different horizon). Upper Cambrian: Limestone north of East Gallatin River, near Hillsdale, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (A. C. Peale, 1888).

Billingsella plicatella.
Huenella abnormis.

158 (same locality as 156, 157, and 158a, but different horizon). Upper Cambrian: Limestone north of East Gallatin River, near Hillsdale, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (A. C. Peale, 1889).

Dicellomus pectenoides.
*Billingsella plicatella.
Eoorthis desmopleura.
Huenella abnormis.

158a (same locality as 156. 157, and 158, but different horizon). Upper Cambrian: Limestone north of East Gallatin River, near Hillsdale, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (A. C. Peale, 1889).

Dicellomus nanus.

159. Middle Cambrian: Limestones north of West Gallatin (Gallatin) River, Gallatin County, Mont. (A. C. Peale, 1884).

Micromitra pealei.
Obolus rotundatus.
Acrotreta attenuata.
Billingsella coloradoensis.
Olenoides?.

160. Upper Cambrian: Sandstones forming a remnant of the Gallatin formation which lies between the exposures of "porphyrite" on the east side of Willow Creek [Peale, 1896, areal geology sheet], 12 miles (19.2 km.) south-southwest of Threeforks, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (A. C. Peale, 1889).

Micromitra (Paterina) superba?.

160a. Upper Cambrian: Sandstone west of Bear Creek, south of the Gallatin Valley southwest of Bozeman, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (A. C. Peale, 1889).

Obolus rotundatus.

161. Upper Cambrian: Limestone on the south side of West Gallatin (Gallatin) River, northwest of Hamilton on the north side of the Gallatin Valley, Gallatin County, Mont. (A. C. Peale, 1884).

Obolus tetonensis.
Lingulella desiderata.

163 (=55c). (For stratigraphic position and association, see p. 152.) (R. S. Spence.,

Micromitra (Iphidella) pannula.
Acrothele subsidua.
*Acrotreta definita.
*Nisusia (Jamesella) nautes.
*Nisusia (Jamesella) spencei.

164. Middle Cambrian: Sandstone in the Deadwood formation in the cliffs on the east side of the valley near Deadwood, Black Hills, South Dakota.

Dicellomus pectenoides.

164f. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales just above a bed of limestone on the road leading northwest out of Montevallo, Shelby County, Ala.

Obolus? sp.

165. Middle Cambrian: Limestone on the east side of the valley, in railroad cut about 1 mile (1.6 km.) below the main part of Deadwood, Black Hills, South Dakota.

Lingulella similis.
Acrotreta idahoensis.
Linnarssonella girtyi.

167. Middle Cambrian: Sandstone beneath limestone and resting on pre-Cambrian "slates, schists, and pegmatites" in bluff 9 miles (14.4 km.) west of Custer, Black Hills, South Dakota.

Lingulella cuneola?.
Lingulella (Lingulepis) acuminata.
Dicellomus politus.

168. Upper Cambrian: Limestones on north side of Tepee Creek, near the road from Sheridan to Dome Lake, Bighorn Mountains, Sheridan County, Wyo. (C. D. Walcott).

Eoorthis desmopleura.
*Eoorthis desmopleura nympha.
Eoorthis remnicha.
Syntrophia primordialis.

170. Middle Cambrian: Sandstone about 10 miles (16.1 km.) south-southeast of Bald Mountain, Bighorn Mountains, Wyo.

Obolus matinalis.
Dicellomus nanus.

171 (200 feet below 171a). Middle Cambrian: Sandstone in Big Goose Creek Canyon, in the Bighorn Mountains, west of Sheridan, Sheridan County, Wyo.

Lingulella (Lingulepis) acuminata (ranging through 200 feet of beds).

171a (200 feet above 171). Middle Cambrian: Sandstone in Big Goose Creek Canyon, in the Bighorn Mountains, west of Sheridan, Sheridan County, Wyo.

Obolus (Westonia) ella.
Lingulella (Lingulepis) acuminata.

174c. (For stratigraphic position and association, see p. 138.) Lower Cambrian: Sandstones on small hill in the salt flat 1 mile (1.6 km.) northeast of Silver Peak mill, Silver Peak quadrangle (U. S. G. S.), Esmeralda County, Nev. (C. D. Walcott and F. B. Weeks, 1896).

*Mickwitzia occidens.
Obolus?.
Obolella sp.

175. (For stratigraphic position and association, see p. 138.) Lower Cambrian: Shales carrying *Olenellus* on the divide between Clayton and Fish Lake valleys, about 15 miles (24.2 km.) south-southwest of the town of Silver Peak, Silver Peak quadrangle (U. S. G. S.), Esmeralda County, Nev. (C. D. Walcott and F. B. Weeks, 1896).

Obolus?.
Kutorgina perugata?.
*Acrotreta claytoni.
Swantonia? sp.

176. (For stratigraphic position and association, see p. 138.) Lower Cambrian: Shales and interbedded limestones between massive limestone containing *Archæocyathus*, at the south end of Deep Spring Valley, Inyo County, Cal. (C. D. Walcott and F. B. Weeks, 1896).

Obolella vermilionensis.
Obolella? sp.
Trematobolus excelsis.
Wanneria gracile Walcott.
Olenellus fremonti Walcott.

176a. (For stratigraphic position and association, see p. 138.) Lower Cambrian: Sandstone on ridge east of the head of Mazouka Canyon, Inyo Range, Inyo County, Cal. (C. D. Walcott, 1897).

Trematobolus excelsis.

178a (slightly higher than 176, but same locality). (For stratigraphic position and association, see p. 138.) (C. D. Walcott and F. B. Weeks, 1896.)

Trematobolus excelsis.
Billingsella highlandensis?.
Wanneria gracile Walcott.
Olenellus fremonti Walcott.

184. (For stratigraphic position and association, see p. 138.) Lower Cambrian: Shales at the summit of the Silver Peak Range, 10 miles (16.1 km.) southwest of the town of Silver Peak, Silver Peak quadrangle (U. S. G. S.), Esmeralda County, Nev. (C. D. Walcott, 1896).

Kutorgina perugata.
Acrotreta claytoni.

185. Upper Cambrian: Sandy layers above the massive Potsdam sandstone 0.5 mile (0.8 km.) southeast of Redwood, Jefferson County, N. Y. (C. D. Walcott, 1886).

Lingulella (Lingulepis) acuminata.

185a. Upper Cambrian: Sandy layers 20 feet (6 m.) above the massive Potsdam sandstone, east side of Indian View, 3 miles (4.8 km.) south of Theresa, Jefferson County, N. Y. (C. D. Walcott, 1886).

Lingulella (Lingulepis) acuminata.

185z. (For stratigraphic position and association, see p. 148.) Lower Ordovician: Limestones at the base of the Lower Ordovician [Walcott, 1908f, p. 191], in Blacksmith Fork Canyon, about 9 miles (14.4 km.) east of Hyrum, Cache County, Utah (C. D. Walcott and L. D. Burling, 1906).

Obolus discoideus.
Eoorthis desmopleura.
Syntrophia nundina.
Orthoceras.
Endoceras.
Fragments of trilobites.

186. Lower Ordovician: Near line of contact between red and gray Ordovician limestone, in red siliceous limestone about 30 feet (9.1 m.) above the pre-Cambrian rocks, Williams Canyon, Manitou, El Paso County, Colo. (C. D. Walcott, 1890).

Lingulella desiderata.
Schizambon manitouensis.
Eoorthis desmopleura.
Eoorthis desmopleura nympha.
Syntrophia nundina.

186a (slightly higher horizon than 186). Lower Ordovician: Near line of contact between red and gray Ordovician limestone, in siliceous red limestone about 35 feet (10.7 m.) above the pre-Cambrian rocks, Williams Canyon, Manitou, El Paso County, Colo. (T. W Stanton, 1890).

*Schizambon manitouensis.
Eoorthis desmopleura.
Syntrophia nundina.

187. Lower Ordovician: Red siliceous limestone 105 to 122 feet (32 to 36.7 m.) above the pre-Cambrian rocks, 2 miles (3.2 km.) below Manitou Park Hotel, El Paso County, Colo. (Whitmau Cross, 1882).

Lingulella desiderata.
Eoorthis desmopleura.

201. (For stratigraphic position and association, see p. 139.) Passage beds between the Upper Cambrian and the Ordovician: Arenaceous Pogonip limestone on east slope of ridge east of Hamburg Ridge Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (Arnold Hague and C. D. Walcott, 1880).

*Lingulella pogonipensis.
Acrotreta idahoensis alta.
Eoorthis hamburgensis.

201a. (For stratigraphic position and association, see p. 139.) Lower Ordovician: Pogonip limestone, east slope of the ridge east of Hamburg Ridge, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1882).

*Obolus (Westonia) iphis.
Lingulella pogonipensis.
*Schizambon typicalis.
Acrothele sp.
Acrotreta idahoensis.
Eoorthis hamburgensis.
Syntrophia nundina.
Agnostus prolongus Hall and Whitfield.

202. (For stratigraphic position and association, see p. 139.) Lower Ordovician: Pogonip limestone on the summit of the ridge directly southeast of the Jackson mine, northwest of Shadow Canyon, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1880).

Lingulella manticula.
Lingulella sp.
Elkania ambigua.
Acrotreta idahoensis.

203. (For stratigraphic position and association, see p. 139.) Lower Ordovician: Pogonip limestone on spur of Hamburg Ridge extending out southwest from Wood Cone, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1880).

Syntrophia nundina.
Bathyurus congeneris Walcott.
Bathyurus tuberculatus Walcott.

203a. (For stratigraphic position and association, see p. 139.) Passage beds between the Upper Cambrian and the Ordovician: Limestones at base of Pogonip limestone in the spur of Hamburg Ridge extending out southwest from Wood Cone, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1880).

Lingulella pogonipensis.
*Acrotreta curvata.
Agnostus tumidosus Hall and Whitfield.

204. (For stratigraphic position and association, see p. 139.) Lower Ordovician: Pogonip limestone on the lower part of the eastern slope of the ridge east of Hamburg Ridge, facing Secret Canyon road, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1880).

*Syntrophia nundina.

205. (For stratigraphic position and association, see p. 139.) Passage beds between the Upper Cambrian and the Ordovician: Siliceous limestone on Roundtop Mountain, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (Arnold Hague and J. P. Iddings, 1880).

Obolus mæra.
*Obolus (Westonia) sp. undt. b.
Lingulella pogonipensis.
*Acrotreta? cancellata.
Eoorthis hamburgensis.

206a. (For stratigraphic position and association, see p. 139.) Passage beds between the Upper Cambrian and the Ordovician: Sandy limestone on Hoosac Mountain, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1880).

Acrotreta idahoensis alta.

209. (For stratigraphic position and association, see p. 139.) Lower Ordovician: Pogonip limestone on the west side of Goodwin Canyon, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (C. D. Walcott, 1880).

Syntrophia nundina.

211. (For stratigraphic position and association, see p. 139.) Passage beds between the Upper Cambrian and the Ordovician: Siliceous Pogonip limestone on spur of Hamburg Ridge extending southwest from Wood Cone, Eureka district [Hague, 1892, Atlas], Eureka County, Nev. (Arnold Hague, J. P. Iddings, and C. D. Walcott, 1880).

Lingulella pogonipensis.

214a (see 313k). (For stratigraphic position and association, see p. 139.) Ordovician: Near the base of the Pogonip limestone, White Pine district, White Pine County, Nev. (C. D. Walcott and C. H. H., 1882).

*Obolus sp. undt. c.

214b (see 313k). (For stratigraphic position and association, see p. 139.) Lower Ordovician: Limestones near the middle of the Pogonip limestone, White Pine district, White Pine County, Nev. (C. D. Walcott and C. H. H., 1882).

Lingulella manticula.

216a. Ordovician: Limestone at Fossil Butte, 10 miles north of Hyko, Lincoln County, Nev. (C. D. Walcott, 1885).

Huenella sp.

220a. Ordovician: Shales of the "Upper Sillery" (Lauzon of Logan) on Chaudiere River, at the Grand Trunk Railroad bridge, Province of Quebec, Canada (C. D. Walcott, 1889).

*Lingulella ellsi.
*Acrothele pretiosa.

221. (For stratigraphic position and association, see p. 139.) Ordovician: Pogonip limestone, below the white quartzite, at the western base of Lone Mountain, Keyes Valley, 18 miles (28.8 km.) northwest of Eureka, Eureka County, Nev. (C. D. Walcott, 1880).

Acrotreta sp. undt.

227. Lower Ordovician: Limestone near Fort Cassin, Addison County, Vt. (W. P. Rust, 1887).

*Syntrophia lateralis.

Localities 300–396z, arbitrarily numbered.[a]

300 [Matthew, 1886, p. 37]. (For stratigraphic position and association, see p. 132.) Middle Cambrian: Shaly sandstones, possibly of Division 1d of Matthew, on Long Reach, St. John River, Kings County, New Brunswick.

*Acrotreta baileyi Matthew.
Ptychoparia robbi ? (Hartt).

301 (references follow species; see 2h). (For stratigraphic position and association, see p. 133.) Middle Cambrian: In sandstones of Division 1b2 of the "*Protolenus* zone" [Matthew, 1895a, p. 108], on Hanford Brook, St. John County, New Brunswick.

Acrothele matthewi lata [Matthew, 1886, p. 42].
Acrotreta baileyi? [Matthew, 1886, p. 37].
Acrotreta gemmula [Matthew, 1895a, p. 126].
*Trematobolus insignis [Matthew, 1895a, p. 123].
*Trematobolus pristinus [Matthew, 1895a, p. 122].
*Beyrichona papilio [Matthew, 1886, p. 66].
*Beyrichona tinea [Matthew, 1886, p. 66].

[a] See the explanatory paragraphs on pp. 160–161.

301a (references follow species). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Fine-grained sandstones below the *Protolenus*-bearing shales and sandstones in Division 1b3 of Matthew, Hanford Brook, St. John County, New Brunswick.

*Acrothele matthewi lata [Matthew, 1895a, Pl. V, fig. 8].
Acrothele matthewi prima [Matthew, 1895a, Pl. V, fig. 7].
*Acrotreta gemmula [Matthew, 1894, p. 88].
*Diplotheca acadica crassa [Matthew, 1886, p. 55].
*Diplotheca hyattiana [Matthew, 1886, p. 52].
*Agraulos? articephalus [Matthew, 1886, p. 75].

301b [Matthew, 1895a, p. 126]. (For stratigraphic position and association, see p. 132.) Middle Cambrian: Sand stones of Division 1b5 and higher of the "*Protolenus* zone" [Matthew, 1895a, p. 108], Hanford Brook, St. John County, New Brunswick.

Acrotreta sagittalis transversa.

301c [Walcott, 1884a, p. 16]. (For stratigraphic position and association, see p. 132.) Middle Cambrian: Sandstones of the St. John formation at Coldbrook, St. John County, New Brunswick.

*Acrotreta sagittalis transversa.
Acrotreta sp.

301d [Matthew, 1895a, p. 128]. (For stratigraphic position and association, see p. 132.) Middle Cambrian: Sandstones of Division 1b5 of Matthew, on Hanford Brook, St. John County, New Brunswick.

Acrothele prima costata.

301e [Matthew, 1903, p. 204]. (For stratigraphic position and association, see p. 131.) Upper Cambrian: In Division C3a of Matthew, in the St. John Basin, St. John County, New Brunswick.

Lingulella cf. lepis.

301f [Matthew, 1905a, p. 128]. (For stratigraphic position and association, see p. 132.) Middle Cambrian: Sandstones of Division 1b5 of the "*Protolenus* zone" of Matthew, at Catons Island, in Long Reach, St. John River, Kings County, New Brunswick.

Acrothele prima costata.

301g (references follow species; see 301w, 308h, and 308i). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Sandstones of Division 1c of Matthew, at Portland (now part of the city of St. John), St. John County, New Brunswick.

Lingulella dawsoni [Matthew, 1886, p. 34]=Lingulella ferruginea.
Acrothele matthewi [Matthew, 1886, p. 41].
Acrothele matthewi lata [Matthew, 1886, p. 41].
*Discinopsis gulielmi [Matthew, 1886, p. 39].
Protorthis billingsi [U. S. National Museum and Matthew, 1886, p. 44].
*Protorthis latourensis (U. S. National Museum).
Protorthis quacoensis [Matthew, 1886, p. 44].
Stenotheca acadica (U. S. National Museum).
Eocystites primævus (U. S. National Museum).
Agnostus vir [U. S. National Museum and Matthew, 1886, p. 70].
Microdiscus dawsoni (U. S. National Museum).
Paradoxides eteminicus (U. S. National Museum).
Paradoxides eteminicus suricoides (U. S. National Museum).
Paradoxides lamellatus (U. S. National Museum).
Paradoxides micmac [U. S. National Museum and Matthew, 1886, p. 81].
Ptychoparia orestes thyrsites (U. S. National Museum).
Ptychoparia (Liostracus) onangondiana (U. S. National Museum).
Ptychoparia (Liostracus) tener (U. S. National Museum).
Ctenocephalus matthewi (U. S. National Museum.)
Ctenocephalus matthewi hispidus (U. S. National Museum).
Ctenocephalus matthewi perhispidus (U. S. National Museum).
Ctenocephalus (Harttella) matthewi (U. S. National Museum).
Conocoryphe (Bailiella) baileyi (U. S. National Museum).
Conocoryphe (Bailiella) baileyi arcuata (U. S. National Museum).
Conocoryphe (Bailiella) elegans (U. S. National Museum),
Conocoryphe (Bailiella) walcotti (U. S. National Museum).

301h (references follow species). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Shales of Division 1c of Matthew, on Hanford Brook, St. John County, New Brunswick.

Lingulella dawsoni [Matthew, 1886, p. 34]=Lingulella ferruginea.
Acrothele matthewi [Matthew, 1886, p. 41].
*Archæocyathus? pavonoides [Matthew, 1886, p. 30].
*Diplotheca acadica obtusa [Matthew, 1886, p. 55].
*Stenotheca nasuta [Matthew, 1886, p. 58].
Agnostus vir [Matthew, 1886, p. 70].
Paradoxides micmac [Matthew, 1886, p. 81].
Eocoryne geminum [Matthew, 1886, p. 31].

301i. (For stratigraphic position and association, see p. 133.) Middle Cambrian: Layers of Division 1b1 of Matthew, on Hanford Brook, St. John County, New Brunswick.

Acrothele matthewi.

301j (references follow species). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Shales of the St. John formation at Ratcliffs Millstream, St. John County, New Brunswick.

Acrothele matthewi [Walcott, 1884a, p. 16]
*Protorthis billingsi [Walcott, 1884a, p. 18]
} These two species may not occur in the same bed.

301k (references follow species; see 308i). (For stratigraphic position and association, see p. 132.) Middle Cambrian: St. John formation in the city of St. John, St. John County, New Brunswick.

Lingula dawsoni [Walcott, 1884a, p. 15]=Lingulella ferruginea.
*Acrothele matthewi [Walcott, 1884a, p. 16].
Acrotreta sagittalis transversa (U. S. National Museum).
Protorthis billingsi (U. S. National Museum).
Eocystites primævus (U. S. National Museum).
Hyolithes danianus (U. S. National Museum).
Stenotheca acadica (U. S. National Museum).
Harttia matthewi (U. S. National Museum).
Agnostus acadicus (U. S. National Museum).
Microdiscus pulchellus (U. S. National Museum).
Microdiscus punctatus (U. S. National Museum).
Paradoxides acadicus (U. S. National Museum).
Paradoxides eteminicus (U. S. National Museum).
Ctenocephalus matthewi (U. S. National Museum).
Conocoryphe matthewi (U. S. National Museum).
Conocoryphe (Bailiella) baileyi (U. S. National Museum).
Conocoryphe (Bailiella) elegans (U. S. National Museum).
Ptychoparia orestes (U. S. National Museum).
Ptychoparia robbi (U. S. National Museum).
Ptychoparia (Liostracus) ouangondiana aurora (U. S. National Museum).
Ptychoparia (Liostracus) tener (U. S. National Museum).

3011 (references follow species). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Shales of Division 1d of Matthew, on Porters Brook, St. Martins, St. John County, New Brunswick.

Lingulella dawsoni [Matthew, 1886, p. 34]=Lingulella ferruginea.
*Lingulella linguloides [Matthew, 1886, p. 34]=Lingulella ferruginea.
Acrothele matthewi [Matthew, 1886, p. 41].
Acrothele prima costata [Matthew, 1895a, p. 128].
Acrotreta misera [Matthew, 1886, p. 36].
*Protospongia (?) minor distans [Matthew, 1886, p. 30].
Eocoryne geminum [Matthew, 1886, p. 31].
*Dendrograpsus (?) primordialis [Matthew, 1886, p. 31].
*Protograpsus alatus [Matthew, 1886, p. 32].
Hyolithes (Camerotheca) danianus [Matthew, 1886, p. 50].
*Hyolithes (Camerotheca) gracilis [Matthew, 1886, p. 51].
Diplotheca acadica [U. S. National Museum and Matthew, 1886, p. 55].
*Diplotheca acadica sericea [U. S. National Museum and Matthew, 1886, p. 55].
*Diplotheca hyattiana caudata [U. S. National Museum and Matthew, 1886, p. 54].
*Stenotheca concentrica [Matthew, 1886, p. 57].
*Stenotheca hicksiana [Matthew, 1886, p. 57].
*Lepiditta curta [Matthew, 1886, p. 62].
*Agnostus acadicus declivis [U. S. National Museum and Matthew, 1886, p. 71].
*Agnostus acutilobus [U. S. National Museum and Matthew, 1886, p. 74].
*Agnostus obtusilobus [Matthew, 1886, p. 73].
*Agnostus tessela [U. S. National Museum and Matthew, 1886, p. 71].
*Agnostus umbo [Matthew, 1886, p. 72].
*Agnostus vir concinnus [U. S. National Museum and Matthew, 1886, p. 70].
Microdiscus punctatus pulchellus [U. S. National Museum and Matthew, 1886, p. 75].
*Paradoxides abenacus [Matthew, 1886, p. 80].
*Solenopleura acadica [Matthew, 1886, p. 77].

301m (references follow species). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Shale of Division 1c of Matthew's section on Porters Brook, St. Martins, St. John County, New Brunswick.

Protorthis quacoensis [Matthew, 1886, p. 44].
*Stenotheca radiata [Matthew, 1886, p. 58].
Hyolithes (Camerotheca) danianus [Matthew, 1886, p. 50].
Eocoryne geminum (U. S. National Museum).

301n [Matthew, 1892, p. 39]. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shales of Division 3a of Matthew, on the "right shore," below the "falls," St. John Harbor, St. John County, New Brunswick.

*Lingulella lævis.

301s [Matthew, 1894, p. 91]. Lower Ordovician: Gray sandstones of Division 3e (?) of Matthew, at McAphee's Corner, Hardingville, St. John County, New Brunswick.

*Lingulella grandis.

301t [Matthew, 1903, p. 201]. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Sandy shales of Division C3a of Matthew, at Carlton shore, near the suspension bridge, St. John, St. John County, New Brunswick.

Lingulella lævis grandis.

301u (references follow species). (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shales of Division C3b of Matthew, in the St. John Basin, St. John County, New Brunswick.

Lingulella cf. lepis [Matthew, 1903, p. 204].
Sphærophthalmus alatus [Matthew, 1903, p. 240].

301v [Matthew, 1890, p. 155]. Lower Cambrian: Sandy shales of Division 2b of the "basal series" of Matthew, on Hanford Brook, St. John County, New Brunswick.

*Rustella major.

The following species were found at the same locality and approximate horizon [Walcott, 1900, p. 322]:

Micromitra (Paterina) labradorica.
Hyolithes cf. communis.
Coleoloides cf. typicalis.

301w (references follow species; see 301g, 308h, and 308i). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Shales of Division 1c2 of Matthew's section at Portland (now part of the city of St. John), St. John County, New Brunswick.

Discinopsis gulielmi (U. S. National Museum).
Acrothele matthewi (U. S. National Museum).
*Protorthis latourensis [U. S. National Museum and Matthew, 1886, pp. 42 and 82].
Protorthis quacoensis (U. S. National Museum).
Hyolithes (Camerotheca) micmac [Matthew, 1886, p. 81].
Stenotheca triangularis [Matthew, 1886, pp. 58 and 83].
Stenotheca (Parmophorella) acadica [Matthew, 1886, p. 60].
Agnostus regulus [Matthew, 1886, pp. 68 and 84].
Microdiscus dawsoni [Matthew, 1886, pp. 75 and 84].
Paradoxides acadicus suricus [Matthew, 1886, p. 78].
Paradoxides eteminicus (U. S. National Museum).
Ctenocephalus matthewi (U. S. National Museum).
Ctenocephalus matthewi hispidus (U. S. National Museum).
Ptychoparia (Liostracus) ouangondiana (U. S. National Museum).
Conocoryphe (Bailiella) baileyi (U. S. National Museum).
Conocoryphe (Bailiella) baileyi arcuata (U. S. National Museum).
Conocoryphe (Bailiella) walcotti (U. S. National Museum).

301x [Matthew, 1891, p. 148, and on label with the specimens in Matthew's collection]. (For stratigraphic position and association, see p. 131.) Middle Cambrian: Sandstones of Division C2c of Matthew, Dunns Shore, Simonds, near St. John, St. John County, New Brunswick.

Lingulella radula aspera=Lingulella radula.

301y [Matthew, 1891, p. 148, and Museum of Comparative Zoology]. For stratigraphic position and association, see p. 131.) Middle Cambrian: Shaly sandstones of Division C2c of Matthew, east side of Courtney Bay, St. John, New Brunswick.

*Lingulella radula aspera=Lingulella radula.

301z (references follow species). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Division 1c of Matthew, on Ratcliffs Millstream, St. John County, New Brunswick.

Lingulella dawsoni [Matthew, 1886, p. 34]=Lingulella ferruginea.
Harttia matthewi [Matthew, 1886, p. 61].
Hyolithes (Camerotheca) danianus [Matthew, 1886, p. 50].
Conocoryphe (Bailiella) elegans (U. S. National Museum).

302 [U. S. National Museum]. Middle Cambrian: Limestone east of West Gallatin (Gallatin) River, above Gallatin, Gallatin County, Mont.

Micromitra pealei.
*Micromitra sculptilis.
Obolus matinalis.
*Acrotreta attenuata.
*Acrotreta attenuata var.
Eoorthis hamburgensis.
Eoorthis sp.

302a [U. S. National Museum]. Middle Cambrian: Limestones at several places on the south side of Gallatin Valley, Gallatin County, Mont.

Micromitra sculptilis.
Acrotreta idahoensis.

302b [U. S. National Museum]. Middle Cambrian: Limestones near Crowfoot Ridge, Gallatin quadrangle (U. S. G. S.), Yellowstone National Park, Wyo.

Micromitra sculptilis.
*Micromitra sp. undt.
Obolus rotundatus.
Lingulella desiderata.
Lingulella sp.
*Lingulella (Lingulepis) acuminata meeki.
Dicellomus nanus.
Acrotreta idahoensis.
Eoorthis remnicha.

These species may not all be from the same bed or from exactly the same locality.

302c [U. S. National Museum]. Upper Cambrian: Shaly limestone on south side of Gallatin Valley, Yellowstone National Park, Wyo.

Micromitra sculptilis.
*Eoorthis iddingsi.

302d [U. S. National Museum]. Upper Cambrian: Limestone 200 yards (183 m.) north of the southwest corner of sec. 18, T. 28 N., R. 113 W., Uinta County, Wyo. (E. E. Smith).

Obolus matinalis.
Obolus sinoe.
Eoorthis iddingsi.

302e [U. S. National Museum]. Upper Cambrian: Limestone near the top of the Deadwood formation in Big Popo Agie Canyon, near Lander, Fremont County, Wyo. (N. H. Darton).

Eoorthis wichitaensis.

302f [U. S. National Museum]. Upper Cambrian: Upper part of the Gallatin formation, north side of Elk Pass, between Buffalo and Slough creeks, Yellowstone National Park, Livingston quadrangle (U. S. G. S.), Mont.

Billingsella coloradoensis.
Otusia sandbergi.

302g [U. S. National Museum]. Upper Cambrian: Limestone on the north slope of Crowfoot Ridge, south of the Gallatin Valley, Gallatin quadrangle (U. S. G. S.), Yellowstone National Park, Wyo.

Billingsella coloradoensis.

302h [U. S. National Museum]. Upper Cambrian: Limestone on the divide between Panther Creek and Gallatin River, Gallatin quadrangle (U. S. G. S.), Yellowstone National Park, Wyo.

Billingsella coloradoensis.

302j [U. S. National Museum records]. Lower Ordovician: Limestone on the east side of West Gallatin (Gallatin) River, above Gallatin, Gallatin County, Mont.

Obolus matinalis.
*Clarkella montanensis.
} These species may not be from the same exact locality.

302k [U. S. National Museum]. Middle Cambrian: Limestone near Gallatin, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont.

Dicellomus politus.

3021 [U. S. National Museum]. Middle Cambrian: Limestone in the Gallatin Range, Yellowstone National Park, Wyo.

*Lingulella desiderata.

302m [U. S. National Museum]. Middle Cambrian: Middle of shale above lower sandstone on Billy Creek, in the Bighorn Mountains, Sheridan County, Wyo. (N. H. Darton, 1902).

Lingulella (Lingulepis) acuminata.
Dicellomus nanus.

302n [U. S. National Museum]. Upper Cambrian: Limestone on the south side of the Gallatin Valley, Gallatin County, Mont.

Eoorthis remnicha.

302o [U. S. National Museum]. Middle Cambrian: Sandstones just above the granite west of Garfield Peak, 50 miles (80.5 km.) west of Casper, Natrona County, Wyo. (N. H. Darton).

*Obolus (Westonia) dartoni.

302p [U. S. National Museum]. Upper Cambrian: Middle limestone of the Deadwood formation near the summit of the Owl Creek Mountains, 18 miles (29 km.) southwest of Thermopolis, Fremont County, Wyo. (N. H. Darton).

Billingsella coloradoensis.
Huenella abnormis.
Ptychoparia.

302q [U. S. National Museum]. Upper Cambrian: About 1,000 feet (305 m.) above the quartzitic sandstones in the "Yogo limestone (Devono-Silurian)" of W. H. Emmons [1907, p. 34], on Rock Creek, Phillipsburg quadrangle (U. S. G. S.), Granite County, Mont. (E. M. Kindle, 1907).

Billingsella coloradoensis.

302r [U. S. National Museum]. Upper Cambrian: About 1,000 feet (305 m.) above the quartzitic sandstones in the "Yogo limestone (Devono-Silurian)" of W. H. Emmons [1907, p. 34], near Princeton, Phillipsburg quadrangle (U. S. G. S.), Granite County, Mont. (E. M. Kindle, 1907).

Obolus cf. discoideus.
Billingsella coloradoensis.
Cyrtolites.
Agraulos.
Anomocare.

302s [U. S. National Museum]. Middle Cambrian: Dark siliceous shale in a quarry iu Last Chance Gulch, south slope of Mount Helena, 1.5 miles (2.4 km.) south of Helena, Jefferson County, Mont.
Obolus (Westonia) ella.
*Lingulella helena.
Dicellomus politus.

302t [U. S. National Museum]. Middle Cambrian: Limestone northeast of Logan, Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont.
Micromitra (Iphidella) pannula.
Acrotreta sp. undt.
Ptychoparia.

302u [U. S. National Museum]. Upper Cambrian: Upper limestone of the Deadwood formation north of Cheever's ranch, on the summit of the Bighorn Mountains, Wyo. (N. H. Darton).
Dicellomus nanus.

302v [U. S. National Museum]. Ordovician: Sandstones 2 miles (3.2 km.) west of the main summit of Buffalo Fork Peak [see St. John, 1877, pp. 468 and 469 and map opposite p. 324 (near station XLIX)], about 25 miles (40 km.) east of Jackson Lake, Uinta County, Wyo.
Dicellomus nanus.

302w [U. S. National Museum]. Middle Cambrian: Limestone at Madison Mountain, Mont.
Acrotreta idahoensis.
Billingsella coloradoensis.

302x [U. S. National Museum]. Middle Cambrian: Sandstones near the head of Powder River, Bighorn Mountains, Wyo. (F. V. Hayden).
Obolus sinoe.

302y [U. S. National Museum]. Middle Cambrian: Sandstone on Johnson Creek, Bighorn Mountains, Wyo. (N. H. Darton, 1902).
Dicellomus nanus.

302z [U. S. National Museum]. Middle Cambrian: Limestone on Mill Creek, near Landusky, Little Rocky Mountains, Chouteau County, Mont. (W. H. Weed).
Dicellomus nanus.

303 [Barrande, 1879b, Pl. XCV]. (For stratigraphic position and association, see p. 124.) Lower Ordovician: Étage d3 at Königshof, Bohemia, Austria-Hungary.
*Acrotreta babel.

303a (references follow species). (For stratigraphic position and association, see p. 124.) Lower Ordovician: Étage d3 at Trubin, Bohemia, Austria-Hungary.
Lingulella? simplex [Barrande, 1879b, Pl. CIV].
Acrotreta babel? [Barrande, 1879b, Pl. XCV].

303b [Barrande, 1879b, Pl. CXXVI]. (For stratigraphic position and association, see p. 124.) Lower Ordovician: Étage d1 in the environs of Rokitzan, Bohemia, Austria-Hungary.
*Obolus? rokitzanensis.

303c (references follow species). (For stratigraphic position and association, see p. 124.) Passage beds between the Upper Cambrian and the Ordovician: Suburbs of Hof, Bavaria, Germany.
*Obolus? bavaricus [Barrande, 1868a, p. 100].
*Obolus? minor [Barrande, 1868a, p. 105].
*Obolus? palliatus [Barrande, 1868a, p. 105].
*Lingulella cedens [Barrande, 1868a, p. 102].
*Lingulella? humillima [Barrande, 1868a, p. 101].
*Lingulella signata [Barrande, 1868a, p. 103].
*Lingulella würthi [Barrande, 1868a, p. 101].
*Acrotreta inchoans [Barrande, 1868a, p. 102].
*Orbiculoidea contraria [Barrande, 1868a, p. 104].
*Orbiculoidea varians [Barrande, 1868a, p. 103].
*Eoorthis bavarica [Barrande, 1868a, p. 99].

303d (references follow species). (For stratigraphic position and association, see p. 124.) Lower Ordovician: Étage d1 at Swarow, Bohemia, Austria-Hungary.
*Obolus? advenus [Barrande, 1879b, Pl. XCV].
Lingulella? insons [Barrande, 1879b, Pl. CV].
*Acrotreta? minima [Barrande, 1879b, Pl. XCV].

303e [Barrande, 1879b, Pl. CV]. (For stratigraphic position and association, see p. 124.) Lower Ordovician: Étage d1 at Sta. Benigna, Bohemia, Austria-Hungary.

*Lingulella? insons.

303f [Pompeckj, 1896a, pp. 7 and 8]. (For stratigraphic position and association, see p. 124.) Passage beds between the Upper Cambrian and the Ordovician: Railway cut near Schellenberg, a little distance back of the railway station at Neuhof, near Hof, Bavaria, Germany.

Lingulella cedens.
Lingulella? humillima.
Lingulella wirthi.
Lingula n. sp.
Acrotreta inchoans.
Acrotreta n. sp.
Orbiculoidea contraria.
Orbiculoidea varians.
Orthis sp.=Eoorthis bavarica.
Macrocystella bavarica.
Bellerophon n. sp.
Bavarilla hofensis.
Dikellocephalus (?) bavaricus.
Niobe innotata.
Niobe discrepans.

303g [Barrande, 1879b, Pl. CXI]. (For stratigraphic position and association, see p. 124.) Lower Ordovician: Étage d1 at Rabenberg, Bohemia, Austria-Hungary.

*Obolus? ancillus.
Obolus? complexus.

303h [Barrande, 1879b, Pl. XCV]. (For stratigraphic position and association, see p. 124.) Lower Ordovician: Étage d1 at Milinsky Wrch, near Woleschna, Bohemia, Austria-Hungary.

Obolus complexus.

303i (references follow species). (For stratigraphic position and association, see p. 124.) Lower Ordovician: Étage d1 at Kruschna Hora, Bohemia, Austria-Hungary.

*Obolus complexus [Barrande, 1879b, Pl. XCV].
*Obolus feistmanteli [Barrande, 1879b, Pl. CX].

303j [Barrande, 1879b, Pl. CVI]. (For stratigraphic position and association, see p. 124.) Lower Ordovician: Étage d1 at Czerhowitz, Bohemia, Austria-Hungary.

Obolus feistmanteli.

303k [Barrande, 1879b, Pl. CXI]. (For stratigraphic position and association, see p. 124.) Lower Ordovician: Étage d1 at Hradischt, Bohemia, Austria-Hungary.

*Obolus? mirandus.

303l [Barrande, 1879b, Pl. CVI]. (For stratigraphic position and association, see p. 124.) Lower Ordovician: Étage d1 at Libetschov, Bohemia, Austria-Hungary.

*Obolus? (Westonia?) lamellosus.
Lingula? eximia.

303m [Barrande, 1879b, Pl. CIV]. (For stratigraphic position and association, see p. 124.) Ordovician: Étage d4 at Lieben, Bohemia, Austria-Hungary.

*Lingulella davidsoni.

303n [Barrande, 1879b, Pl. CIV]. (For stratigraphic position and association, see p. 124.) Ordovician: Étage d4 at Wraž, Bohemia, Austria-Hungary.

Lingulella davidsoni.

303o [Barrande, 1879b, Pl. CIV]. (For stratigraphic position and association, see p. 124.) Ordovician: Étage d4 at Lodenitz, Bohemia, Austria-Hungary.

Lingulella davidsoni.

303p [Barrande, 1879b, Pl. CIV]. (For stratigraphic position and association, see p. 124.) Lower Ordovician: Étage d3 in the environs of Beraun, Bohemia, Austria-Hungary.

*Lingulella? simplex.

304 [Matley, 1902, p. 145]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: "Bronsil" shales at White Leaved Oak, Malvern Hills, between Herefordshire and Worcestershire, England.

Acrotreta belti.

304a [Groom, 1902, p. 110]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: "Bronsil" shales, Malvern Hills, between Herefordshire and Worcestershire, England.

Obolus (Bröggeria) salteri.
Lingulella nicholsoni.
Lingulella? sp.=Acrothyra?.
Lingula sp.
Acrotreta belti.
Acrotreta cf. nicholsoni.
Acrotreta sabrinæ.
Acrotreta cf. socialis.
Dictyonema sociale Salter.
Tomaculum problematicum Groom.
(?) Hyolithes assulatus Groom.
Agnostus dux Callaway.
Cheirurus frederici Salter.
Platypeltis croftii Callaway?.
Asaphellus affinis McCoy?.
Parabolinella (?) triarthrus Callaway?.
Acanthopleurella grindrodi Groom.
Niobe homfrayi Salter?.
(?) Niobe? sp., near O. peltata Salter.

304b [Groom, 1902, p. 109]. (For stratigraphic position and association, see p. 135.) (See 304f, the "black shales" being another name for the "White Leaved Oak shales"). Upper Cambrian: Lower part of the "White Leaved Oak" shales (the zone of *Polyphyma*), Malvern Hills, between Herefordshire and Worcestershire, England.

Micromitra pusilla.
Lingulella nicholsoni (doubtfully).
Acrotreta sabrinæ.
Polyphyma lapworthi Groom.
Small ostracod.
Protospongia fenestrata Salter.
Plant remains (?).
Agnostus sp.

304c [Groom, 1902, p. 94]. (For stratigraphic position and association, see p. 136.) Lower Cambrian: "Malvern quartzite" at Raggedstone Hill, Malvern Hills, between Herefordshire and Worcestershire, England.

Micromitra (Paterina) phillipsi.
Obolella groomi.
Hyolithes fistula (Holl).
Hyolithes primævus Groom.

304d [Groom, 1902, p. 94]. (For stratigraphic position and association, see p. 136.) Lower Cambrian: "Malvern quartzite" at Midsummer Hill, Malvern Hills, between Herefordshire and Worcestershire, England.

Micromitra (Paterina) phillipsi.
Obolella groomi.

304e [Davidson, 1866, p. 62]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Upper part of the black "White Leaved Oak" shales at Coal Hill, east end of the Malvern Hills, between Herefordshire and Worcestershire, England.

*Obolus (Bröggeria) salteri.

304f [Salter, 1865, p. 102]. (For stratigraphic position and association, see p. 135.) (See 304b, the "black shales" being another name for the "White Leaved Oak shales.") Upper Cambrian: "Black shales" in the Malvern Hills, between Herefordshire and Worcestershire, England.

*Lingulella (Lingulepis?) pygmæa.

304g (references follow species). (For stratigraphic position and association, see p. 135.) Upper Cambrian: Sandstones of the Hollybush series (horizon of Middle *Lingula* beds [Davidson, 1866, p. 63]), Malvern Hills, between Herefordshire and Worcestershire, England.

*Micromitra (Paterina) phillipsi [Holl, 1865, p. 89].
*Lingulella (Lingulepis?) squamosa [Holl, 1865, p. 102].

Groom [1902, p. 109] cites the following from the "Hollybush sandstones":

Micromitra phillipsi.
Acrotreta sagittalis?.
Hyolithes fistula (Holl).
Hyolithes malvernensis Groom.
Hyolithes primævus Groom.
Hyolithes, 2 or more species.
Coleoloides? sp.
Scolecoderma antiquissima (Salter).
Modiolopsis? sp.
Foraminifera (glauconitic casts).

304h [U. S. National Museum]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Shineton shales, Mary Dingle, South Shropshire, England.

Acrotreta nicholsoni.
*Acrotreta sabrinæ.

304i [Callaway, 1877, p. 669]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Shineton shale at Shineton, Mary Dingle, Dryton, Cressage, 1 mile (1.6 km.) west of Cressage, west of Harley, and under Cound-Moor quarry, all in South Shropshire, England.

*Lingulella nicholsoni.
Acrotreta sabrinæ.

304j [Mason College collections]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower Stockingford shales, Puxley Park Lane, halfway up the path to the quarry, Atherstone, Warwickshire, England (C. A. Matley, 1894).

Acrothele intermedia?.
Acrotreta sabrinæ.

304k [Davidson, 1883, pp. 208 and 209]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Shineton shale at Bull Hill Cottage and Pewardine, both in South Shropshire, England.
Lingulella nicholsoni.

304l [Geol. Survey Great Britain]. (See 304p.) (For stratigraphic position and association, see p. 135.) Upper Cambrian: Shineton shales at the following localities of the Geological Survey of Great Britain: 2246, 2481, 2499, 2512, 2513, 2541, 2548, 2556, 2567, 2625, and 2627, all of which are on Shineton Brook and vicinity, South Shropshire, England.
Lingulella nicholsoni.

304n [McCoy, 1854, p. 254]. (For stratigraphic position and association, see p. 135.) Ordovician: "Coniston (Bala) limestone" at Coniston, Lancashire, England.
Lingulella davisi.

304o [U. S. National Museum]. (For stratigraphic position and association, see p. 136.) Lower Cambrian: Sandstone at Nuneaton, England.
Micromitra (Paterina) labradorica.

304p [Geol. Survey Great Britain]. (See 304l.) (For stratigraphic position and association, see p. 135.) Upper Cambrian: Shineton shales at the following localities of the Geological Survey of Great Britain: 2495, 2536, 2543, 2545, 2558, and 2580, all of which are on Shineton Brook, South Shropshire, England (Chas. Lapworth).
Acrotreta sabrinæ.

305 [Davidson, 1871, p. 341]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower Tremadoc shales, Craig-y-dinas, North Wales.
*Acrotreta belti.

305a [Davidson, 1866, desc. of Pl. III]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Upper Tremadoc beds at Moel-y-gest, northwest side, Carnarvonshire, North Wales.
Lingulella lepis.

305c. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower Tremadoc slate, everywhere in the Tremadoc district, Carnarvonshire, North Wales.
Lingulella lepis.

305d [Davidson, 1866, p. 54]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: In the Upper *Lingula* flags near Tremadoc, Carnarvonshire, North Wales.
Lingulella lepis?.

305e [Davidson, 1866, p. 54]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Upper Tremadoc beds near Tai-hirion, Arenig, North Wales.
Lingulella lepis.

305f [Davidson, 1866, p. 54]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower Tremadoc beds east of Pont Nant-y-Ladron, on the Bala road from Ffestiniog, Merionethshire, North Wales.
Lingulella lepis.

305g [Davidson, 1866, p. 54]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower Tremadoc at Wern, North Wales.
Lingulella lepis.

305h [Davidson, 1866, p. 54]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower Tremadoc at Borthwood, North Wales.
*Lingulella lepis.

305i [Davidson, 1866, p. 54]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower Tremadoc at Trwyn-y-Iago, North Wales.
Lingulella lepis.

305j [Davidson, 1866, p. 54]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower Tremadoc at Cefn Cyfarnedd, North Wales.
Lingulella lepis.

306 [Geol. Survey Canada]. Upper? Cambrian: Sandy limestone on Gravel River, eastern slope of the Rocky Mountains, in the Mackenzie basin, British Columbia (J. Keele, 1908).
Billingsella coloradoensis.
Eoorthis desmopleura?.

307 (references follow species). (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shales of Division C3c of Matthew on McLeod Brook (=Barachois River), Cape Breton, Nova Scotia.

Obolus refulgens [Matthew, 1903, p. 213].
*Lingulella concinna [Matthew, 1903, p. 204].
Leptobolus gemmulus [Matthew, 1903, p. 192]=Lingulella ferruginea.
Leptobolus cf. linguloides [Matthew, 1903, p. 193]=Lingulella ferruginea.
Linnarssonia cf. belti [Matthew, 1903, p. 210].
*Acrotreta bisecta [Matthew, 1903, p. 187].
*Schizambon priscus [Matthew, 1903, p. 188].

307a (references follow species). (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shales of Division C3c2 of Matthew [1903, p. 240], on McLeod Brook (=Barachois River), near Boisdale, eastern Cape Breton, Nova Scotia.

*Lingulella cf. davisi [Matthew, 1903, p. 203].
*Lingulella cf. lepis [Matthew, 1903, p. 240].
Lingulella cf. linguloides [Matthew, 1903, p. 240]=Lingulella ferruginea.
Acrotreta sipo [Matthew, 1903, p. 186]=Acrotreta bisecta.
*Urotheca sp. [Matthew, 1903, p. 183].
*Modiolopsis? cf. solvensis [Matthew, 1903, p. 217].
*Bellerophon bretonensis [Matthew, 1903, p. 218].
*Bellerophon insulæ [Matthew, 1903, p. 217].
*Bellerophon semisculptus [Matthew, 1903, p. 219].
*Parabolinella? cf. limitis [Matthew, 1903, p. 226].
*Parabolinella? quadrata [Matthew, 1903, p. 226].
*Triarthrus belli [Matthew, 1903, p. 231].
*Angelina? sp. [Matthew, 1903, p. 232].
*Asaphellus homfrayi var. [Matthew, 1903, p. 235].
*Asaphellus? planus [Matthew, 1903, p. 238].

307b [U. S. National Museum]. (For stratigraphic position and association, see p. 131.) Middle Cambrian: Sandstone on McPhees Brook, Cape Breton, Nova Scotia.

Lingulella radula.

307c [Matthew, 1903, p. 205]. (For stratigraphic position and association, see p. 131.) Middle Cambrian: Sandstones probably belonging with Division C2c of Matthew, on Mira River, eastern Cape Breton, Nova Scotia.

Lingulella radula.

307d (references follow species). (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandy limestone of Division E2a? of Matthew's Etcheminian on Young (McFees) Point [Matthew, 1903, p. 19], near George River station, Cape Breton, Nova Scotia.

*Obolus æquiputeis [Matthew, 1903, p. 140]=Obolus selwyni.
*Obolus selwyni [Matthew, 1903, p. 123].
*Lingulella atava insulæ [Matthew, 1903, p. 110].
Obolus discus [Matthew, 1903, p. 79]=Lingulella triparilis.
*Lingulella (Lingulepis) roberti [Matthew, 1903, p. 132].
Acrotreta sp. [Matthew, 1903, p. 96].
*Billingsella retroflexa [Matthew, 1903, p. 149].
*Hyolithes cf. tenuistriatus [Matthew, 1903, p. 83].
*Paradoxidoid trilobite [Matthew, 1903, p. 176].
*Holasaphus centropyge [Matthew, 1903, p. 176].
*Eurypterid (?) crustacean [Matthew, 1903, p. 79].

307e [Matthew, 1903, p. 216]. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Limestone in Division C3b? (possibly C3c) on Gillis Brook, eastern Cape Breton, Nova Scotia.

Orusia lenticularis.

307f [Matthew, 1903, p. 198]. (For stratigraphic position and association, see p. 132.) Middle Cambrian: Shales of Division C2a on McLean Brook, Mira River, Cape Breton, Nova Scotia.

Lingulella (Lingulepis) exigua.

307g (references follow species). (For stratigraphic position and association, see p. 132.) Middle Cambrian: Shales of Division C2b on McLean Brook, above Marion Bridge, Mira River, Cape Breton, Nova Scotia.

Lingulepis starri var. [Matthew, 1903, p. 195]=Lingulella (Lingulepis) exigua.
Lingulepis starri exigua [Matthew, 1903, p. 198]=Lingulella (Lingulepis) exigua.
Beyrichia triceps [Matthew, 1903, p. 220].

307h [Matthew, 1903, p. 216]. (For stratigraphic position and association, see p. 131.) Upper Cambrian: In Division C3b? (possibly C3c) on McLeod Brook (=Barachois River), eastern Cape Breton, Nova Scotia.

Orusia lenticularis.

307i (references follow species). (For stratigraphic position and association, see p. 131.) Upper Cambrian: In Division C3b of Matthew's section on McNeil Brook, east of Mira River, eastern Cape Breton, Nova Scotia.

Orusia lenticularis [Matthew, 1903, p. 216].
*Agnostus acadicus cf. declivis [Matthew, 1903, p. 223].
Agnostus trisectus? [Matthew, 1903, p. 223].
Sphærophthalmus alatus [Matthew, 1903, p. 229].
Peltura scarabæoides [Matthew, 1903, p. 223].
Ctenopyge lobata? [Matthew, 1903, p. 223].

307j (references follow species). (For stratigraphic position and association, see p. 131.) Upper Cambrian: Limestone in Division C3b? (possibly C3c), on East Bay, east of Bras d'Or Lake, eastern Cape Breton, Nova Scotia.

Orusia lenticularis [Matthew, 1903, p. 216].
*Agnostus trisectus germanus [Matthew, 1903, p. 221].
*Agnostus cf. cyclopyge [Matthew, 1903, p. 222].
*Parabolina dawsoni [Matthew, 1903, p. 224].
Ctenopyge pecten [Matthew, 1903, p. 230].

308 (references follow species). (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shales of Division C3c of Matthew, at Navy Island, St. John Harbor, New Brunswick.

*Obolus refulgens [Matthew, 1892, p. 45].
*Obolella gemmula [Matthew, 1892, p. 41]=Lingulella ferruginea.
Schizambon priscus [Matthew, 1901a, p. 278].
Acrotreta baileyi [Matthew, 1892, p. 43]=Acrotreta bisecta.
*Linnarssonia belti? [Matthew, 1892, p. 42].

308a [Matthew, 1893b, p. 103]. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Dark shales of Division C3a of Matthew's section of the St. John terrane, Navy Island, St. John Harbor, St. John County, New Brunswick.

*Eoorthis atava.

308b (references follow species). (For stratigraphic position and association, see p. 131.) Upper Cambrian: Limestone lentiles in black shales of Division C3a of Matthew's section, Germaine Street, St. John, St. John County, New Brunswick.

Orusia lenticularis [Matthew, 1892, p. 48].
*Orusia lenticularis atrypoides [Matthew, 1892, p. 48].
*Orusia lenticularis lyncioides [Matthew, 1892, p. 48].
*Eoorthis johannensis [Matthew, 1892, p. 49].
Parabolina spinulosa [Matthew, 1892, p. 51].
Protopeltura acanthura tetracanthura [Matthew, 1892, p. 53].
Conocephalites contiguus [Matthew, 1892, p. 58].

308c [Matthew, 1891, p. 147]. (For stratigraphic position and association, see p. 132.) Upper Cambrian: Shales of Division 2b of Matthew's Johannian at St. John, St. John County, New Brunswick.

*Lingulella (Lingulepis) starri.

308d [Matthew, 1894, p. 121]. (For stratigraphic position and association, see pp. 132 and 133.) Middle Cambrian: Sandstones of Division C1b2–4 of Matthew's section on Catons Island, in Long Reach, St. John River, Kings County, New Brunswick.

*Botsfordia pulchra.

308e [Matthew, 1895a, p. 126]. (See 2f and 2g.) (For stratigraphic position and association, see p. 133.) Middle Cambrian: Beds of Division C1b1 of the "*Protolenus* zone" [Matthew, 1895a, p. 108], on Hanford Brook, St. John County, New Brunswick.

Botsfordia cælata.

308f (references follow species). (For stratigraphic position and association, see p. 131.) Upper Cambrian: Limestone lentiles in black shales of Division C3a of Matthew's section, King Street, St. John, St. John County, New Brunswick.

Orusia lenticularis [Matthew, 1903, p. 216].
Ctenopyge pecten [Matthew, 1903, p. 229].

308g [Matthew, 1897, p. 71]. (See 2u.) (For stratigraphic position and association, see p. 132.) Middle Cambrian: Shales of Division 1b3 or 1b4 of Matthew's section on Long Island [Matthew, 1898, pp. 124 and 127], Kennebecasis Bay, St. John County, New Brunswick.

*Trematobolus kempanum.

308h [U. S. National Museum]. (See 301g, 301w, and 308i.) (For stratigraphic position and association, see p. 132.) Middle Cambrian: Shales of Division 1c1 of Matthew's section at Portland (now part of the city of St. John), St. John County, New Brunswick.

Discinopsis gulielmi.
Acrothele matthewi.
Protorthis billingsi.
Protorthis latourensis.
Eocystites primævus Billings.
Hyolithes micmac Matthew.
Microdiscus dawsoni Hartt.
Paradoxides eteminicus Matthew.
Paradoxides lamellatus Hartt.
Paradoxides micmac.
Ctenocephalus matthewi perhispidus.
Ptychoparia (Liostracus) tener (Hartt).

308i [U. S. National Museum]. (See 301g, 301k, 301w, and 308h.) For stratigraphic position and association, see p. 132.) Middle Cambrian: Shales in Portland (now a part of the city of St. John), St. John County, New Brunswick.

Protorthis billingsi.
Paradoxides sp.

309 (references follow species). (For stratigraphic position and association, see p. 144.) Passage beds between the Cambrian and Ordovician: *Ceratopyge* limestone (zone 4 of Moberg and Segerberg) at Fogelsång, 5 miles (8 km.) east of Lund, Province of Malmöhus, Sweden.

Obolus (Bröggeria) salteri [Moberg and Segerberg, 1906, desc. of Pl. I].
Lingula? producta [Moberg and Segerberg, 1906, p. 63]= Lingulella lepis.
Lingula? ordovicensis [Moberg and Segerberg, 1906, p. 63]=Lingulella lepis.
*Acrotreta carinata [Moberg and Segerberg, 1906, desc. of Pl. III].
*Acrotreta circularis [Moberg and Segerberg, 1906, p. 66].
Obolella (Acrotreta?) sagittalis [Moberg and Segerberg, 1906, desc. of Pl. I]=Acrotreta sagittalis.
Capulus ceratopygarum [Moberg and Segerberg, 1906, desc. of Pl. III].
Agnostus sidenbladhi urceolatus [Moberg and Segerberg, 1906, desc. of Pl. IV].
Agnostus fossulatus [Moberg and Segerberg, 1906, desc. of Pl. IV].
Euloma ornatum [Moberg and Segerberg, 1906, desc. of Pl. IV].
Harpides rugosus [Moberg and Segerberg, 1906, desc. of Pl. V].
Ceratopyge latelimbata [Moberg and Segerberg, 1906, desc. of Pl. V].
Symphysurus angustatus [Moberg and Segerberg, 1906, desc. of Pl. V].
Symphysurus elongatus [Moberg and Segerberg, 1906, desc. of Pl. V].
Nileus armadillo [Moberg and Segerberg, 1906, desc. of Pl. VI].
Niobe insignis angustifrons [Moberg and Segerberg, 1906, desc. of Pl. VI].
Niobe læviceps [Moberg and Segerberg, 1906, desc. of Pl. VI].
Megalaspis intacta [Moberg and Segerberg, 1906, desc. of Pl. VI].
Orometopus elatifrons [Moberg and Segerberg, 1906, desc. of Pl. VII].
Cyrtometopus sp. [Moberg and Segerberg, 1906, desc. of Pl. VII].
Harpina (Harpes) excavata? [Moberg and Segerberg, 1906, desc. of Pl. VII].
Crossoura parvula [Moberg and Segerberg, 1906, desc. of Pl. VII].

309a [Moberg and Segerberg, 1906, p. 62]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: *Bryograptus* slate (zone 2) at Fogelsång, 5 miles (8 km.) east of Lund, Province of Malmöhus, Sweden.

Lingulella lepis.
Lingula? bryograptorum=Lingulella lepis.

309b [Moberg and Segerberg, 1906, p. 63]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: *Dictyograptus* slate (zone 1) at Flagabro, Province of Malmöhus, Sweden.

Lingula? corrugata=Lingulella lepis.

309c [Linnarsson, 1869a, p. 357; and U. S. National Museum]. (For stratigraphic position and association, see p. 146.) Lower Cambrian: "Fucoid sandstone" at Billingen, east of Skara, Province of Skaraborg, Sweden.

Obolella (Glyptias) favosa.

309d [Linnarsson, 1869a, p. 357]. (For stratigraphic position and association, see p. 146.) Lower Cambrian: "Fucoid sandstone" at Lugnås, 23 miles (37 km.) northeast of Skara, Province of Skaraborg, Sweden.

*Obolella (Glyptias) favosa.

309e [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Shales of the *Acerocare* zone at Åkarpsmölla, midway between Kågeröd and Röstånga, Province of Malmöhus, Sweden (J. C. Moberg).

Eoorthis christianiæ.

309f [U. S. National Museum]. (For stratigraphic position and association, see p. 146.) Middle Cambrian: Shale at Borgholm, Oeland Island, Sweden.

Acrothele (Redlichella) granulata

309h [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Limestones of the *Dictyograptus flabelliformis* zone at Fogelsång, 5 miles (8 km.) east of Lund, Province of Malmöhus, Sweden.

Obolus (Bröggeria) salteri.

309i [U. S. National Museum]. (See 390g.) (For stratigraphic position and association, see p. 145.) Upper Cambrian: Limestones at Sandby, 6 miles (9.6 km.) east-northeast of Lund, Province of Malmöhus, Sweden.

Obolus (Bröggeria) salteri.

309j [U. S. National Museum]. (See 309m and 320q.) (For stratigraphic position and association, see p. 145.) Upper Cambrian: Shale at Alunbruk (alum works), southern part of Oeland Island, Sweden.

Obolus (Bröggeria) salteri.

309l [U. S. National Museum]. (See 310h.) (For stratigraphic position and association, see p. 145.) Upper? Cambrian: Shale collected somewhere in Sweden, exact locality unknown.

Obolus (Bröggeria) salteri.

309m [U. S. National Museum]. (See 309j.) (For stratigraphic position and association, see p. 145.) Upper Cambrian: Limestones forming 3c of the *Olenus* series at Alunbruk (alum works), southern part of Oeland Island, Sweden (Schmalensee, 1899).

Orusia lenticularis.

310 (references follow species). (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: *Ceratopyge* limestone (zone 4 of Moberg and Segerberg), Ottenby, Oeland Island, Sweden.

Lingula producta [Moberg and Segerberg, 1906, p. 63]= Lingulella lepis.
Lingula ordovicensis [Moberg and Segerberg, 1906, p. 63]= Lingulella lepis.
Acrothele barbata [Moberg and Segerberg, 1906, p. 67]= Acrothele ceratopygarum.
?Acrotreta circularis [Moberg and Segerberg, 1906, p. 66].
Acrotreta carinata [Moberg and Segerberg, 1906, p. 66].
Eoorthis christianiæ [Moberg and Segerberg, 1906, desc. of Pl. III]=Eoorthis daunus.
Eostrophomena elegantula [Moberg and Segerberg, 1906, desc. of Pl. III].
Lamanskya splendens [Moberg and Segerberg, 1906, desc. of Pl. III].
Meristella difformis [Moberg and Segerberg, 1906, desc. of Pl. III].
Agnostus sidenbladhi urceolatus [Moberg and Segerberg, 1906, desc. of Pl. IV].
Agnostus trinodus [Moberg and Segerberg, 1906, desc. of Pl. IV].
Triarthrus angelini [Moberg and Segerberg, 1906, desc. of Pl. IV].
Acerocare n. sp.? [Moberg and Segerberg, 1906, desc. of Pl. IV].
Ceratopyge forficula [Moberg and Segerberg, 1906, desc. of Pl. V].
Dikellocephalus bröggeri [Moberg and Segerberg, 1906, desc. of Pl. V].
Apatocephalus serratus [Moberg and Segerberg, 1906, desc. of Pl. V].
Symphysurus angustatus [Moberg and Segerberg, 1906, desc. of Pl. V].
Symphysurus breviceps [Moberg and Segerberg, 1906, desc. of Pl. V].
Nileus armadillo [Moberg and Segerberg, 1906, desc. of Pl. VI].
Niobe insignis [Moberg and Segerberg, 1906, desc. of Pl. VI].
Niobe læviceps [Moberg and Segerberg, 1906, desc. of Pl. VI].
Niobe obsoleta [Moberg and Segerberg, 1906, desc. of Pl. VI].
Megalaspis planilimbata [Moberg and Segerberg, 1906, desc. of Pl. VII].
Illænus oriens [Moberg and Segerberg, 1906, desc. of Pl. VII].
Orometopus elatifrons? [Moberg and Segerberg, 1906, desc. of Pl. VII].
Holometopus törnquisti [Moberg and Segerberg, 1906, desc. of Pl. VII].
Cyrtometopus primigenus [Moberg and Segerberg, 1906, desc. of Pl. VII].
Cyrtometopus speciosus [Moberg and Segerberg, 1906, desc. of Pl. VII].

310a [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Shales of *Olenus truncatus* zone, Oeland Island, Sweden.

*Acrotreta conula.
Orusia lenticularis.
Olenus truncatus Brünn.

310b [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Dark-brown limestone at Borgholm, Oeland Island, Sweden.

Acrotreta schmalenseei.
Billingsella exporrecta.
} These two species may not occur in the same bed.

310c [Wallerius, 1895, p. 66]. (See 310p.) (For stratigraphic position and association, see p. 146.) Middle Cambrian: Limestone of the *Paradoxides œlandicus* zone on Oeland Island, Sweden.

Acrotreta schmalenseei.

310d [U. S. National Museum]. (See 390i.) (For stratigraphic position and association, see p. 145.) Upper Cambrian: *Ceratopyge* slate at Borgholm, Oeland Island, Sweden (Schmalensee, 1899).

Obolus (Bröggeria) salteri.
Lingulella ferruginea.
Lingulella lepis.
*Acrothele borgholmensis.
Acrotreta seebachi.
Eoorthis christianiæ.
Orthoid.

310e [Moberg, 1892b, p. 115]. (For stratigraphic position and association, see p. 146.) Lower Cambrian: Sandstone bowlder on the beach between Ekerum and Stora Rör, on Oeland Island, Sweden.

*Acrothele sp. undt.

310f [Moberg, 1892b, p. 115]. (For stratigraphic position and association, see p. 146.) Lower Cambrian: Drift blocks of glauconitic quartzitic sandstone west of Ekerum, Kalmar sheet (Geol. Survey Sweden), Oeland Island, Sweden.

Micromitra (Paterina) undosa.
Acrothele sp. undt.
Discinella.

310g [Moberg, 1892b, p. 115]. (For stratigraphic position and association, see p. 146.) Lower Cambrian: Sandstone bowlders south of Stora Rör, on Oeland Island, Sweden.

Acrothele sp. undt.

310h [U. S. National Museum]. (See 3091.) (For stratigraphic position and association, see p. 145.) Upper? Cambrian: Shale collected somewhere (probably Fogelsång) in the old Province of Skåne, now the Provinces of Malmöhus and Christianstad, Sweden.

Lingulella concinna.
Obolus (Bröggeria) salteri.
Billingsella exporrecta.

310i [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Passage beds between the Middle Cambrian *Paradoxides forchhammeri* zone and the Upper Cambrian *Olenus truncatus* zone: Limestone at Borgholm, Oeland Island, Sweden.

*Lingulella agnostorum.
Acrothele coriacea.
Acrotreta parvula.
Agnostus lævigatus Dalman.

310j [U. S. National Museum]. (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: *Ceratopyge* limestone at Borgholm, Oeland Island, Sweden.

Lingulella lepis.
Eoorthis daunus.
Eoorthis wimani.
*Eostrophomena elegantula.

310k [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Oeland Island, Sweden.

*Lingulella sp. undt. a.

3101 [U. S. National Museum]. (See 8w, 320f, and 321y.) (For stratigraphic position and association, see p. 145.) Middle Cambrian: In the *Paradoxides forchhammeri* zone at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad, Sweden.

*Dicellomus sp. undt.

310m [Linnarsson, 1876, p. 16]. (See 310o.) (For stratigraphic position and association, see p. 146.) Middle Cambrian: Arenaceous shales of the *Paradoxides tessini* zone on Oeland Island, Sweden.

Lingulella ferruginea.

310n [Moberg and Segerberg, 1906, p. 65]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: In the "*Obolus* sandstone?" in Dalarne, Province of Kopparberg, Sweden.

Obolus triangularis.

310o [U. S. National Museum]. (See 310m.) (For stratigraphic position and association, see p. 146.) Middle Cambrian: Limestone in the *Paradoxides tessini* zone at Borgholm, Oeland Island, Sweden.

Lingulella ferruginea.
Acrothele (Redlichella) granulata.

310p (references follow species). (See 310c.) (For stratigraphic position and association, see p. 146.) Middle Cambrian: Limestone of the *Paradoxides œlandicus* zone at Borgholm, Oeland Island, Sweden.

Lingulella ferruginea (U. S. National Museum).
Acrotreta socialis [Linnarsson, 1876, p. 18]=Acrotreta schmalenseei.

310q [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestone of the *Agnostus lævigatus* zone at Lovened, Province of Skaraborg, Sweden.

Lingulella ferruginea.

310r [Westergård, 1909, p. 76]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Zone *v* of the *Ceratopyge* slate at Ottenby, Oeland Island, Sweden.

*Acrotreta œlandica.

310s [Westergård, 1909, p. 76]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Uppermost part of the Alum slate in beds equivalent to the *Ceratopyge* slate, northern part of Oeland Island, Sweden.

Acrotreta œlandica.

310t [Westergård, 1909, p. 57]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Subzone *c* of the *Dictyograptus* slate at Fogelsång, 5 miles (8 km.) east of Lund, Province of Malmöhus, Sweden.
*Acrotreta sp. undt.

310u [Westergård, 1909, p. 77]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Subzone *c* of the *Dictyograptus* slate at Jerrestad, Province of Malmöhus, Sweden.
Acrotreta sp.

310v [Westergård, 1909, p. 77]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Subzone *b* of the *Dictyograptus* slate at Tosterup, 7.5 miles (12 km.) north-northeast of Ystad, Province of Malmöhus, Sweden.
Acrotreta sp.

310w [Westergård, 1909, desc. of Pl. II]. (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: Zone *c* at Grönhögen, Oeland Island, Sweden.
Lingulella lepis.

310x [Westergård, 1909, p. 76]. (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: The uppermost limestone stratum in beds equivalent to the *Ceratopyge* limestone at Jerrestad, Province of Malmöhus, Sweden.
*Obolus? inflatus.

310y [Linnarsson, 1879, p. 25, and U. S. National Museum.] (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestone at Kiviks Esperöd, Province of Malmöhus, Sweden.
Lingulella ferruginea.

310z [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestone at Brantevik, on the shore a little south of Simrishamn, Province of Christianstad, Sweden.
Lingulella ferruginea.
Billingsella exporrecta.

311 [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of coarse-grained, somewhat friable, glauconitic sandstone, No. 3, on Eggegrund Island, about 25 miles (40 km.) northeast of Gefle, Province of Gefleborg, Sweden.

*Obolus (Westonia) bottnicus.
Lingula sp.
Kutorgina?.
*Acrotreta eggegrundensis.
Aparchites? anderssoni.
Hipponicharion matthewi.
Torellella lævigata.
Olenellus?.

311a [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of glauconitic sandstone at Norrskedika, a little northwest of Östhammar, Province of Stockholm, Sweden.
Acrotreta eggegrundensis.

311b [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of bituminous sandstone, No. 2, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.
*Acrotreta uplandica.

311c [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of bituminous sandstone, No. 7, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.

*Obolus (Westonia) wimani.
Lingula or Lingulella.
Torellella laevigata.
Beyrichona gevalensis.
Olenellus sp.

311d [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of glauconitic sandstone south of Lumparströmmen, Åland Island, Finland, Russia.
Acrotreta eggegrundensis.

311e [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of rusty sandstone south of Lumparn, parish of Jomala, Åland Island, Finland, Russia.
Mickwitzia monilifera.
Obolus (Westonia) bottnicus?.

311f [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of gray quartzitic sandstone at Slemmern, Mariehamn, Åland Island, Finland, Russia.
Mickwitzia monilifera.

311g [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of bituminous sandstone, No. 16, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.

Obolus (Westonia) wimani.
Lingula sp.
Torellella lævigata.

311h [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of bituminous sandstone, No. 26, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.

*Obolus (Westonia) balticus.

311i [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of bituminous sandstone, No. 27, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.

Obolus (Westonia) wimani.

311j [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of bituminous sandstone, No. 28, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.

Obolus (Westonia) ålandensis.
Lingula or Lingulella.

311k [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of bituminous sandstone, No. 29, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.

Obolus (Westonia) ålandensis.
Torellella lævigata.

311l [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of bluish calcareous sandstone, No. 31, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.

*Mickwitzia formosa.
Mickwitzia monilifera.

311m [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of bituminous sandstone, No. 1, on Limön Island, about 12 miles (19.3 km.) east-northeast of Gefle, Province of Gefleborg, Sweden.

Obolus (Westonia) ålandensis.
Beyrichona alta.
Torellella lævigata.

311n [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of blue calcareous sandstone, No. 6, on Limön Island, about 12 miles (19.3 km.) east-northeast of Gefle, Province of Gefleborg, Sweden.

*Acrotreta uplandica limöensis.
Acrotreta sp.
Torellella lævigata.
Ellipsocephalus sp.
Trilobite (not Olenellus).

311o [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of bituminous sandstone, No. 1, on Skälstenarne Island, just west of Eggegrund Island, about 25 miles (40 km.) east-northeast of Gefle, Province of Gefleborg, Sweden.

Obolus (Westonia) balticus.

311p [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of glauconitic sandstone, No. 1, at Höganäs, parish of Börstil, east of Östhammar, Province of Stockholm, Sweden.

Lingula or Lingulella.
Acrotreta uplandica.

311q [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of gray quartzitic sandstone at Ytternäset, Mariehamn, Åland Island, Finland, Russia.

Mickwitzia monilifera.

311r [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of gray quartzitic sandstone at Granboda, Lemland, Åland Island, Finland, Russia.

Mickwitzia monilifera.

311s [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of gray quartzitic sandstone at Skarpnåtö, Åland Island, Finland, Russia.

Mickwitzia formosa.
Stenotheca sp.

311t [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of mottled calcareous sandstone at Öfverby, parish of Jomala, Åland Island, Finland, Russia.

Obolus (Westonia) balticus.
Obolus (Westonia) wimani.
Lingula or Lingulella.
Ellipsocephalus latus.

311u [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of blue calcareous sandstone at Söderarm lighthouse, near Norrtelje, Province of Stockholm, Sweden.

Mickwitzia monilifera.

311v [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlder of *Obolus* sandstone, Ersholmen Island, parish of Börstil, southeast of Öregrund, Province of Stockholm, Sweden.

Obolus apollinis.

311w [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlder of *Obolus* sandstone at Mariehamn, Åland Island, Finland, Russia.

Obolus apollinis.
Orthis sp.

311x [U. S. National Museum]. (For stratigraphic position and association, see p. 146.) Middle Cambrian: Compact, fine-grained, quartzitic sandstone at Saltvik, Åland Island, Finland, Russia (Schmalensee, 1901).

*Obolus (Westonia) finlandensis.
Elipsocephalus (Liostracus) muticus Angelin.

311y [Wiman, 1902, p. 57]. (For stratigraphic position and association, see p. 146.) Middle? Cambrian: Drift bowlder of rusty sandstone at Ytternäs, Slemmern, Åland Island, Finland, Russia.

*Obolus (Westonia) ålandensis.
Lingula or Lingulella.
Bradorona nitida.
Trilobite (not Olenellus).

312 [U. S. National Museum]. (For stratigraphic position and association, see p. 138.) Lower Cambrian: Sandstones of 3d of the Waucoba Springs section [Walcott, 1908f, p. 187], east of Saline Valley road, east of Waucoba Springs, Inyo County, Cal.

Trematobolus excelsis.
Cruziana.
Holmia rowei.

312a [U. S. National Museum]. (For stratigraphic position and association, see p. 138.) Lower Cambrian: Sandstones of 3b of the Waucoba Springs section [Walcott, 1908f, p. 187], east of the Saline Valley road, east of Waucoba Springs, Inyo County, Cal.

Obolella vermilionensis.
Trematobolus excelsis.

313 [U. S. National Museum]. (For stratigraphic position and association, see p. 139.) Upper Cambrian: Limestone 0.75 mile (1.2 km.) east-northeast of McGill post office, White Pine County, Nev.

Micromitra (Paterina) crenistria.
Lingulella desiderata.
Lingulella isse.
Acrotreta idahoensis.

313a [U. S. National Museum]. (Compare 313d and 313f.) (For stratigraphic position and association, see p. 140.) Middle Cambrian: Limestone at Schellbourne, Schell Creek Range, White Pine County, Nev.

Lingulella arguta?.

313b [U. S. National Museum]. (For stratigraphic position and association, see p. 139.) Middle Cambrian: Limestone 3 miles (4.8 km.) north-northeast of Schellbourne, Schell Creek Range, White Pine County, Nev.

Micromitra (Paterina) crenistria.
Lingulella desiderata.
Acrotreta idahoensis alta.

313c [U. S. National Museum]. (For stratigraphic position and association, see p. 139.) Middle? Cambrian: Limestone 12 miles (19.3 km.) west-southwest of Alpha Station, Eureka County, Nev.

Lingulella acutangula.
Lingulella desiderata.

313d [U. S. National Museum]. (Compare 313a and 313f.) (For stratigraphic position and association, see p. 139.) Lower Ordovician: Limestone at Schellbourne, Schell Creek Range, White Pine County, Nev.
*Obolus rotundatus.

313e [U. S. National Museum]. (For stratigraphic position and association, see p. 139.) Middle Cambrian: Limestone 2 miles (3.2 km.) west of Green's ranch, White Pine County, Nev. (O. H. Hershey).
Lingulella arguta.
Linnarssonella girtyi.

313f [U. S. National Museum]. (Compare 313a and 313d.) (For stratigraphic position and association, see p. 139.) Upper Cambrian: Limestone at Schellbourne, Schell Creek Range, White Pine County, Nev.
*Lingulella arguta.
*Lingulella manticula. } These species are probably from more than one horizon.
*Acrotreta pyxidicula.

313g [U. S. National Museum]. (For stratigraphic position and association, see p. 158.) Lower Cambrian: Limestone at the southern end of the Timpahute Range, Groome district, near the line between Nye and Lincoln counties, Nev.
*Nisusia (Jamesella) erecta.
Billingsella sp.
Callavia nevadensis Walcott.
Olenellus fremonti Walcott.
Peachella iddingsi (Walcott).

313h [U. S. National Museum]. (For stratigraphic position and association, see p. 139.) Upper Cambrian: Sandy shale on Hamburg Ridge, Eureka district [Hague, 1892, Atlas], Eureka County, Nev.
*Linnarssonella minuta.

313i [U. S. National Museum]. (For stratigraphic position and association, see p. 138.) Lower Cambrian: Limestone collected at long. 117° 20′ W., lat. 38° N., in the western part of Esmeralda County, Nev.
Kutorgina perugata.

313j [Hall and Whitfield, 1877, pp. 205 and 206]. (Specimens in U. S. National Museum.) (For stratigraphic position and association, see p. 139.) Upper Cambrian: Limestone in the Eureka district [Hague, 1892, Atlas], Eureka County, Nev.
*Obolus discoideus.
*Obolus mæra.
These species, in all probability, did not occur together; Hall and Whitfield give no further data, however, concerning their occurrence.

313k [U. S. National Museum]. (See 214a and 214b.) (For stratigraphic position and association, see p. 139.) Ordovician: Limestone in the White Pine district, White Pine (?) County, Nev.
Linnarssonella minuta.

314 (references follow species). (For stratigraphic position and association, see p. 140.) Middle Cambrian: Limestone in *Paradoxides* zone, Chapple Arm, Trinity Bay, Newfoundland.
*Acrotreta misera [Billings, 1872b, p. 470].
*Agraulos socialis [Billings, 1872b, p. 472].
*Solenopleura communis [Billings, 1872b, p. 474].
*Anapolenus venustus [Billings, 1872b, p. 474].
*Paradoxides tenellus [Billings, 1872b, p. 476].
*Paradoxides decorus [Billings, 1872b, p. 476].

314a [Whiteaves, 1878, p. 226]. (For stratigraphic position and association, see p. 140.) Upper Cambrian: Shales on Kelleys Island, Conception Bay, Newfoundland.
*Lingulella billingsiana.

314b [Matthew, 1899e, p. 97]. (For stratigraphic position and association, see p. 141.) Lower Cambrian: Upper limestone of Matthew's Etcheminian at Smith Sound, Trinity Bay, Newfoundland.
*Kutorgina granulata.

314c [Billings, 1865a, p. 220]. (For stratigraphic position and association, see p. 140.) Lower Ordovician: Nodules of white limestone belonging to Division P of Billings's section at Cow Head, Newfoundland.
Syntrophia calcifera.
Bathyurus saffordi.

314d [Billings, Paleozoic fossils, vol. I]. (For stratigraphic position and association, see p. 140.) Lower Ordovician: Limestone of Division P of the "Quebec group" 4 miles (6.4 km.) northeast of Portland Creek, Newfoundland.

*Obolus cyane (p. 216).
*Lingulella iole (p. 215).
*Acrotreta gemma (p. 217).
*Orthis delicatula (p. 217).
Strophomena aurora (p. 218).
Camerella parva (p. 219).
Camerella varians (p. 220).
Nileus scrutator (p. 274).
Illænus fraternus (p. 276).
*Harpides atlanticus (p. 281).
*Harpides concentricus (p. 282).
Shumardia glacialis (p. 283).
Cheirurus polydorus (p. 286).
Cheirurus sol (p. 288).
Amphion barrandei (p. 288).
Triarthrus fischeri (p. 291).
Telephus americanus (p. 291).
Encrinurus mirus (p. 292).
Remopleurides? schlotheimi (p. 294).
Ampyx normalis (p. 295).
*Ampyx rutilius (p. 296).
Ampyx semicostatus (p. 297).
Agnostus fabius (p. 298).
Agnostus galba (p. 297).

314e (references follow species). (For stratigraphic position and association, see p. 141.) Lower Cambrian: Limestone at Topsail Head, Conception Bay, Newfoundland.

Micromitra (Paterina) bella [Billings, 1872b, p. 478].
Scenella reticulata [Billings, 1872b, p. 479].
Agraulos strenuus [Billings, 1872b, p. 473.]

Walcott [1886a, p. 150] adds the following species:

Salterella.
Micromitra (Paterina) labradorica?.
Stenotheca rugosa (Hall).
Protypus senectus parvulus.

314f [U. S. National Museum]. (For stratigraphic position and association, see p. 141.) Lower Cambrian: Limestone of B7 of the section at Bonne Bay [Walcott, 1891b, p. 255], Newfoundland.

Obolella chromatica.
Micromitra (Paterina) labradorica.
Mesonacis vermontana (Hall).
Conocephalites.
Bathyurus.
Salterella.

314g [Billings, 1865b, p. 362]. (For stratigraphic position and association, see p. 140.) Lower Ordovician: A loose piece of gray argillaceous limestone at Maiden Arm, Hare Bay, on the east side of the northern point of Newfoundland.

*Obolus? murrayi.

314h [U. S. National Museum]. (For stratigraphic position and association, see p. 140.) Middle Cambrian: Shale on Manuels Brook, Conception Bay, Newfoundland.

Acrotreta misera.

314i [U. S. National Museum]. (For stratigraphic position and association, see p. 140.) Upper Cambrian: Shale picked up on beach in Smith Sound, Trinity Bay, Newfoundland (C. D. Walcott, 1899).

Orusia lenticularis.

315 (references follow species). Middle? Cambrian: Limestone at Curramulka, Yorke Peninsula, South Australia.

*Micromitra (Paterina) etheridgei [Tate, 1892, p. 184].
Kutorgina peculiaris [Tate, 1892, p. 185].
*Nisusia compta [Tate, 1892, p. 185].

315a [Tate, 1892, p. 185]. Middle? Cambrian: Limestone at Parara, near Ardrossan, Yorke Peninsula, South Australia.

*Kutorgina peculiaris.

315b [Etheridge, 1905a, p. 249]. Middle? Cambrian: Limestone at Wirrialpa, Flinders Range, South Australia.

*Eoorthis tatei.

315c [Etheridge, 1905, p. 250]. Middle? Cambrian: "Archæocyathinæ white limestone" at Wirrialpa, Flinders Range, South Australia.

*Huenella etheridgei.

315d [Etheridge, 1905, p. 248, and U. S. National Museum]. Lower? Cambrian: Limestone near Wirrialpa, Flinders Range, South Australia.

*Obolella wirrialpensis.

316 [Davidson, 1871, p. 343]. (For stratigraphic position and association, see p. 135.) Lower Ordovician: Upper Llandeilo (?) black shales at Dobbs Linn, near Moffat, in Dumfriesshire, Scotland.

*Acrotreta nicholsoni.

316a [Davidson, 1883, p. 213]. (For stratigraphic position and association, see p. 135.) Lower Ordovician: Llandeilo at Craighead, Ardmillan Brae, and Balcletchie, all three in the Girvan district of Ayrshire, Scotland.
Acrotreta nicholsoni.

316b [Davidson, 1883, p. 211]. (For stratigraphic position and association, see p. 136.) Middle Cambrian: At Cairn Burn and Druidhill Burn, both in Dumfriesshire, Scotland.
Acrotreta sagittalis.

316c [Geol. Survey Scotland, M4197d; personal communication, J. Horne, 1910]. (For stratigraphic position and association, see p. 136.) Lower Cambrian: Probably equivalent to those in band 6 or 7 of the section on the north slope of Meall á Ghiubhais [Peach and Horne, 1907, p. 414], on the Bruachaig River, 2 miles (3.2 km.) east-northeast of the Kinlochewe Hotel, Loch Maree, Ross-shire, Scotland.
*Lingulella zeus.
Olenellus lapworthi? Peach and Horne.

316d [Geol. Survey Scotland, M2646e, M2647e, and M4178d; personal communication, J. Horne, 1910]. (For stratigraphic position and association, see p. 136.) Lower Cambrian: About 500 feet (152.5 m.) above the provisional base of the Cambrian and 75 feet (23 m.) below what is believed to be the top of the Lower Cambrian, in the shales forming 5 and 6 of the section given by Peach and Horne [1907, p. 414], in a small burn on the north slope of Meall á Ghiubhais, 4 miles (6.4 km.) west-northwest of the Kinlochewe Hotel, Loch Maree, Ross-shire, Scotland.
*Micromitra scotica.
Olenellus lapworthi? Peach and Horne.

317 [Davidson, 1883, p. 213]. Lower Ordovician: Coalpit Bay, County Down, Ireland.
Acrotreta nicholsoni.

317a [Davidson, 1871, p. 340]. Middle Cambrian: At Bellewstown, County Meath, and at Balbriggan, County Dublin, both in Ireland.
Acrotreta sagittalis?.

317b [Davidson, 1866, p. 58]. Middle Cambrian: Shales at Bellewstown, County Meath, Ireland.
Lingulella davisi.

318 [Davidson, 1869, p. 232]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Upper *Lingula* flags at Penmain Pool, west of Dolgelly, Merionethshire, North Wales.
Orusia lenticularis.

318a [Davidson, 1868, p. 314]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Upper *Lingula* flags at Criccieth, Carnarvonshire, North Wales.
Orusia lenticularis.

318b [Davidson, 1869, p. 232]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Upper *Lingula* flags near Portmadoc, Carnarvonshire, North Wales.
Orusia lenticularis.

318c [Davidson, 1868, p. 310]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower *Lingula* flags at the Rheider Waterfall Valley and at Gwynfynydd and other places near Dolgelly, North Wales.
Acrotreta sagittalis.

318d (references follow species). (For stratigraphic position and association, see p. 136.) Middle Cambrian: Sandstones in the middle portion of the Menevian at Porth-y-rhaw, St. Davids, South Wales.
Acrothele maculata [Davidson, 1871, p. 341].
*Orbiculoidea pileolus [Davidson, 1868, p. 316].
*Billingsella hicksi [Davidson, 1869, p. 230].

318e (references follow species). (For stratigraphic position and association, see p. 136.) Middle Cambrian: Lower portion of the Menevian at Camlan, North Wales.
Lingulella ferruginea [Davidson, 1871, p. 337].
Acrothele maculata [Davidson, 1871, p. 341].
Orbiculoidea pileolus [Davidson, 1871, p. 345].

318f [Davidson, 1871, p. 341]. (For stratigraphic position and association, see p. 136.) Middle Cambrian: Lower portion of the Menevian at Gwynfynydd, North Wales.
Acrothele maculata.

318g [Davidson, 1868, p. 310]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower *Lingula* flags at Porth-y-rhaw, Pen-y-pleidiau, and several other localities near St. Davids, South Wales.
*Acrotreta sagittalis.

318h [U. S. National Museum]. (For stratigraphic position and association, see p. 136.) Middle Cambrian: Shales in the Menevian at St. Davids, South Wales.

Lingulella ferruginea.
Acrothele maculata.
Acrotreta sagittalis.
Billingsella hicksi.

318i [U. S. National Museum]. (See 366c.) (For stratigraphic position and association, see p. 136.) Middle? Cambrian: Red shales of the Caerfai group at St. Davids, South Wales.

Lingulella primæva.

318j [Salter, 1866b, p. 340]. (For stratigraphic position and association, see p. 136.) Middle Cambrian: Black shales of the Menevian group at Pen-y-pleidiau, St. Davids, South Wales.

*Lingulella ferruginea.

318k [Davidson, 1871, p. 337]. (For stratigraphic position and association, see p. 136.) Middle Cambrian: In the Menevian rocks at Tafern Helig, North Wales.

Lingulella ferruginea.

318l [Davidson, 1871, p. 337]. (For stratigraphic position and association, see p. 136.) Middle Cambrian: In the Menevian rocks at the Waterfall Valley, near Maentwrog, North Wales.

Lingulella ferruginea.

318m [Davidson, 1866, p. 57]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Near the base of the lower black slates at the Waterfall Valley, near Maentwrog, North Wales.

Lingulella davisi.

318n [Davidson, 1871, p. 337]. (For stratigraphic position and association, see p. 136.) Middle Cambrian: Red shales at the base of the Harlech grits at St. Davids, South Wales.

Lingulella ferruginea.

318o [Davidson, 1871, p. 337]. (For stratigraphic position and association, see p. 136.) Middle Cambrian: Red shales at the base of the Harlech grits at Solva, St. Davids, South Wales.

Lingulella ferruginea.

318p (references follow species). (For stratigraphic position and association, see p. 136.) Middle Cambrian: Sandstones in the middle portion of the Menevian at Ninewells, near St. Davids, South Wales.

Orbiculoidea pileolus [Davidson, 1871, p. 344].
*Billingsella hicksi [U. S. National Museum and Davidson, 1869, p. 230].

318q [Davidson, 1871, pp. 344–345]. (For stratigraphic position and association, see p. 136.) Middle Cambrian: Yellowish-gray beds in the Harlech group, on the road between Solva and Whitechurch, St. Davids, South Wales.

Orbiculoidea pileolus?.

318r [Davidson, 1871, p. 344]. (For stratigraphic position and association, see p. 136.) Middle Cambrian: Sandstones in the middle portion of the Menevian at Solva Harbor, St. Davids, South Wales.

Orbiculoidea pileolus.

318s [Davidson, 1868, p. 314]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Upper *Lingula* flags at Ogof-ddu Cliff, Carnarvonshire, North Wales.

Orusia lenticularis.

318t [Davidson, 1868, p. 314]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Upper *Lingula* flags at Penmorfa Church, Tremadoc, Carnarvonshire, North Wales.

Orusia lenticularis.

318u (references follow species). (For stratigraphic position and association, see p. 135.) Upper Cambrian Upper *Lingula* flags at Gwerny-y-Barcud, North Wales.

Lingulella ferruginea [Davidson, 1868, p. 315].
Orusia lenticularis [Davidson, 1868, p. 314].

318v (references follow species). (For stratigraphic position and association, see p. 135.) Upper Cambrian: Upper *Lingula* flags at Rhiwfelyn, North Wales.

Lingulella ferruginea [Davidson, 1868, p. 315].
Orusia lenticularis [Davidson, 1869, p. 232].

318w [U. S. National Museum]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Tremadoc shale on Ramsey Island, St. Davids, South Wales.

Eoorthis carausii.

319 [Geol. Survey Canada]. (See 319i; may be same locality.) Lower Ordovician: Limestone No. 1 of Billings's Point Levis section, Point Levis, Province of Quebec, Canada.

*Elkania ida.
*Acrotreta ovalis.

The following species are quoted from this locality by Billings, Paleozoic Fossils, vol. 1:

Metoptoma venillia (p. 88).
*Orthis ? apicalis (p. 301).
*Agnostus canadensis (p. 397).
*Agnostus orion (p. 397).
*Conocephalites zenkeri (p. 398).
*Arionellus cylindricus (p. 406).
*Arionellus subclavatus (p. 406).
*Menocephalus globosus (p. 408).
*Menocephalus sedgwicki (p. 407).
*Dikellocephalus belli (p. 403).
*Dikellocephalus cristatus (p. 404).
*Dikellocephalus hisingeri (p. 196).
*Dikellocephalus magnificus (p. 399).
*Dikellocephalus megalops (p. 403).
*Dikellocephalus oweni (p. 402).
*Dikellocephalus pauper (p. 200).
*Dikellocephalus planifrons (p. 401).
*Dikellocephalus selectus (p. 199).
*Dikellocephalus sesostris (p. 198).
*Bathyurus armatus (p. 411).
*Bathyurus capax (p. 409).
*Bathyurus dubius (p. 410).

319a (references follow species). Lower Ordovician: Levis shales, Point Levis, Province of Quebec, Canada.

*Lingulella irene [Billings, 1862b, p. 72].
*Elkania desiderata [U. S. National Museum and Billings, 1862b, p. 70].
*Acrothele levisensis (Geol. Survey Canada).
Lingulella sp. undt. (U. S. National Museum).

319b [U. S. National Museum]. Lower Cambrian: Conglomeratic limestones containing *Olenellus?*, St. Simon, Rimouski (?) County, Province of Quebec, Canada.

Bicia gemma.
Obolella crassa.
*Obolella crassa elongata.
*Acrothele sp. undt. a.
Hyolithes americanus Billings.
Olenellus?.
Agraulos redpathi Walcott.

Billingsella salemensis occurs at the same locality as the specimens mentioned above, but its stratigraphic position is not known.

319c [Billings, 1862b, p. 69]. Ordovician: Shales at Cape Rouge, above Quebec, Province of Quebec, Canada.

Acrothele pretiosa.

319d [Billings, 1865a, p. 301]. Upper Cambrian: Limestone bowlder in Lower Ordovician conglomerate, Point Levis, Quebec, Canada.

*Lingulella iris.

319e (references follow species). Lower Cambrian: Sandy shales about 2 miles (3.2 km.) east of Swanton, Franklin County, Vt. (See Locality 25a; the only known locality is nearly 2 miles east of Swanton, and Locality 319e has therefore been entered as 2 miles, though Billings gives it as 1.5 miles.)

Kutorgina cingulata [Billings, 1861b, p. 9].
*Nisusia festinata [Billings, 1861b, p. 10].
*Swantonia antiquata [U. S. National Museum and Billings, 1861b, p. 11].

319f [U. S. National Museum]. Lower Ordovician: Drift bowlder of sandstone found near St. Albans, Franklin County, Vt. The lithologic characters of the matrix in which this species was found point to the arenaceous limestones of the Phillipsburg formation just north of the boundary between the United States and Canada as the source of the bowlder.

*Billingsella dice.

319g [Whitfield, 1884, p. 144]. Lower Cambrian: Shales at Parker's quarry, near Georgia, Franklin County, Vt.

*Billingsella orientalis.
Olenellus thompsoni.

319h [U. S. National Museum]. Lower Cambrian: Limestone bowlders in conglomerate at Metis, on the St. Lawrence, below Quebec, Canada.

Billingsella salemensis.
Hyolithellus micans (Billings).
Olenellus? sp.
Ptychoparia metisensis Walcott.

319i [Billings, 1862b, p. 71, and Geol. Survey Canada]. (See 319; may be same locality.) Lower Ordovician: Limestone at Point Levis, Province of Quebec, Canada.

Elkania ida.

319j [U. S. National Museum]. (See 319k.) Lower Cambrian: Sandstone 50 feet (15 m.) above the base of the section west of Parker's quarry and about a mile (1.6 km.) from the shore of Lake Champlain, in the township of Georgia, Franklin County, Vt.

Botsfordia cælata.
Hyolithellus micans (Billings).
Hyolithes americanus Billings.
Hyolithes communis Billings.
Hyolithes sp.
Olenellus? sp.
Ptychoparia trilineata (Emmons).

319k [U. S. National Museum records]. (See 319j.) Lower Cambrian: Calcareous sandstone near the base of the section west of Parker's quarry, on cliff overlooking Lake Champlain, near Georgia, Franklin County, Vt.
Obolella crassa.

3191 [Billings, 1872a, p. 220, and U. S. National Museum.] Lower Cambrian: Limestone bowlders in conglomerate at Trois Pistoles, Temiscouata County, on St. Lawrence River, below Quebec, Canada.
*Quebecia circe.

319m [Walcott, 1891b, p. 278]. Lower Cambrian: Shales of No. 6 of the section at Parker's quarry, near Georgia, Franklin County, Vt.

Kutorgina cingulata.
Billingsella orientalis.
Nisusia festinata.
Nisusia festinata transversa.
*Palæophycus congregatus Billings.
*Palæophycus incipiens Billings.
Phyllograptus (?) cambrensis Walcott.
*Climacograptus (?) emmonsi Walcott.
*Microdiscus parkeri.
*Mesonacis vermontana (Hall).
*Olenellus thompsoni (Hall).
*Olenoides marcoui (Whitfield).
*Bathynotus holopyga (Hall).
Ptychoparia adamsi (Billings).
Ptychoparia vulcanus (Billings).
*Protypus hitchcocki (Whitfield).
Protypus senectus (Billings).
Protypus senectus parvulus (Billings).

319n [Billings, 1859, p. 432]. Ordovician: "Chazy formation" on the island of Montreal, in St. Lawrence River, Canada.
*Obolus belli.

319o [Billings, 1859, p. 432]. Ordoviciau: "Chazy formation" near L'Original, on St. Lawrence River, Canada.
Obolus belli.

319p [Billings, 1859, p. 432]. Ordovician: "Chazy formation" on Allumette Island, in St. Lawrence River, Canada.
Obolus belli.

319q [U. S. National Museum records]. Upper Cambrian: Limestone 1 mile (1.6 km.) south-southwest of Highgate Falls, Franklin County, Vt.
Obolus mæra?.

319r [U. S. National Museum]. (See 319e and 25a.) Lower Cambrian: On the Bullard farm, about 2 miles (3.2 km.) east of Swanton, Franklin County, Vt.
Rustella edsoni.
Olenellus thompsoni (Hall).

319s [U. S. National Museum]. Middle Cambrian: "St. Albans formation" at St. Albans, Franklin County, Vt.
Obolus matinalis?.
*Huenella vermontana.
Paradoxides sp.

319t [Billings, 1865a, p. 220]. Lower Ordovician: "Calciferous sandrock" at St. Timothy, on the St. Lawrence, near the head of the Beauharnois Canal, Province of Quebec, Canada.
Syntrophia calcifera.

319u [Billings, 1861a, p. 320]. Lower Ordovician: "Calciferous sandrock" in the township of Edwardstown, between Beauharnois and Lake Champlain, Province of Quebec, Canada.
Syntrophia calcifera.

319v [U. S. National Museum]. (See 319y.) Lower Cambrian: Sandy shale 2 miles (3.2 km.) east of Highgate Springs, Franklin County, Vt. (C. D. Walcott, 1889).
Lingulella franklinensis.

319w [U. S. National Museum]. (See 319x.) Lower Cambrian: Limestone 1.25 miles (2 km.) north of Rutland, Rutland County, Vt. (T. N. Dale).
Nisusia festinata.

319x [U. S. National Museum]. (See 319w.) Lower Cambrian: Limestone at the crossing of East Creek and Grove Street, 1.25 miles (2 km.) north of Rutland, Rutland County, Vt. (A. F. Foerste, 1890).
Micromitra (Paterina) labradorica swantonensis.

319y [U. S. National Museum]. (See 26 and 319v.) Lower Cambrian: Sandstone 2 miles (3.2 km.) east-southeast of Highgate Springs, Franklin County, Vt. (C. D. Walcott, 1889).
Micromitra (Paterina) labradorica swantonensis.
Stenotheca rugosa (Hall).
Ptychoparia sp.

319z [U. S. National Museum]. (See 25a.) Lower Cambrian: Sandy limestone 2.5 miles (4 km.) east of Swanton, Franklin County, Vt. (C. D. Walcott, 1897).
Micromitra (Paterina) labradorica swantonensis.

320 [Wallerius, 1895, p. 66]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Gudhem, 12.5 miles (20.1 km.) south-southeast of Skara, Province of Skaraborg, Sweden.
Acrotreta parvula.

320a [Wallerius, 1895, p. 66]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Djupadal, 19 miles (30.6 km.) south-southeast of Skara, Province of Skaraborg, Sweden.
*Acrotreta parvula.
Agnostus lævigatus Dalman.

320b [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones forming 2d of the *Paradoxides* zone, the *Agnostus lævigatus* horizon, at Gudhem, 12.5 miles (20.1 km.) south-southeast of Skara, Province of Skaraborg, Sweden.
Acrothele coriacea.
Acrothele (Redlichella) granulata.
*Billingsella exporrecta.
*Billingsella exporrecta rugosicostata.

320c [Wallerius, 1895, p. 66]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Andrarum limestone at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad, Sweden.
Acrotreta schmalenseei.

320d [U. S. National Museum]. (For stratigraphic position and association, see p. 146.) Middle Cambrian: *Exsulans* limestone in the lower part of the *Paradoxides tessini* zone at Fogelsång, 5 miles (8 km.) east of Lund, Province of Malmöhus, Sweden.
Acrotreta schmalenseei.

320e [U. S. National Museum]. (See 321q.) (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestone at Munkesten, north of Hunneberg, Province of Skaraborg, Sweden.
Acrotreta schmalenseei.

320f [U. S. National Museum]. (See 8w, 310l, and 321y.) (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestone at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad, Sweden.
Micromitra pusilla.
Micromitra (Iphidella) ornatell.
Acrothele coriacea.
Orusia lenticularis.

320g [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones of the *Paradoxides forchhammeri* zone at Borgholm, Oeland Island, Sweden.
Acrothele coriacea.
Billingsella exporrecta.

320h [Grönwall, 1902, p. 39]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Shales in the *Paradoxides tessini* zone at Lovened, 19 miles (30.6 km.) south-southeast of Skara, Province of Skaraborg, Sweden.
Acrothele intermedia.

320i [Grönwall, 1902, p. 39]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones of the *Coronatus* zone at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad, Sweden.
Acrothele intermedia.

320j [Grönwall, 1902, p. 39]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones of the *Coronatus* zone at Gislöf, Province of Malmöhus, Sweden.
Acrothele intermedia.

320k (references follow species). (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones at Kiviks Esperöd, Province of Malmöhus, Sweden.

Acrothele coriacea (U. S. National Museum).
*Acrothele intermedia [Grönwall, 1902, p. 39].

The exact horizon from which the specimens of *Acrothele coriacea* were obtained is not known. *Acrothele intermedia* was obtained from the *Coronatus* zone.

3201 (references follow species). (For stratigraphic position and association, see p. 146.) Middle Cambrian: Drift blocks supposed to have come from the *Paradoxides œlandicus* zone [Linnarsson, 1876, p. 6], at Lillviken, near Oestersund, Province of Jemtland, Sweden.

*Obolus sp. undt. g [Linnarsson, 1876, p. 16].
Acrothele coriacea [Linnarsson, 1876, p. 23].
*Acrothele (Redlichella) granulata [Linnarsson, 1876, p. 24]. (Referred to as "A. coriacea.")
Billingsella exporrecta [Linnarsson, 1876, p. 13].
Billingsella lindströmi [Linnarsson, 1876, p. 12].

320m (references follow species). (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones of the *Paradoxides forchhammeri* zone at Kinnekulle, northeast of Lidköping, Province of Skaraborg, Sweden.

Lingula or Lingulella [Linnarsson, 1876, p. 15]=Lingulella ferruginea.
*Acrothele coriacea [Linnarsson, 1876, p. 23].
Acrotreta socialis [Linnarsson, 1876, p. 18]=Acrotreta schmalenseei.
Billingsella exporrecta [Linnarsson, 1876, p. 13].
Orthis aff. hicksi [Linnarsson, 1876, p. 14]=Billingsella exporrecta rugosicostata.
*Billingsella lindströmi [U. S. National Museum and Linnarsson, 1876, pp. 11, 12, and 33].

320n (references follow species). (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones of the *Paradoxides forchhammeri* zone at Lovened, Djupadal, 19 miles (30.6 km.) south-southeast of Skara, Province of Skaraborg, Sweden.

*Micromitra (Iphidella) ornatella [U. S. National Museum and Linnarsson, 1876, p. 26].
Lingula or Lingulella [Linnarsson, 1876, p. 16]=Lingulella ferruginea.
*Lingulella linnarssoni (U. S. National Museum).
Acrothele coriacea [U. S. National Museum and Linuarsson, 1876, p. 23].
Acrotreta schmalenscei (U. S. National Museum).
Acrotreta socialis (U. S. National Museum).
*Billingsella exporrecta [U. S. National Museum and Linnarsson, 1876, pp. 13 and 33].
Billingsella exporrecta rugosicostata (U. S. National Museum).
Orthis aff. hicksi [Linnarsson, 1876, p. 14]=Billingsella exporrecta rugosicostata.
Billingsella lindströmi (U. S. National Museum).

320o [Linnarsson, 1876, p. 23]. (For stratigraphic position and association, see p. 146.) Middle Cambrian: Limestone band between the *Holmia kjerulfi* zone and the *Paradoxides tessini* zone at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad, Sweden.

Acrothele coriacea.

320p (references follow species). (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones of the *Paradoxides forchhammeri* zone at Södra Möckleby, southern part of Oeland Island, Sweden.

Acrothele coriacea [Linnarsson, 1876, p. 23].
Billingsella exporrecta [Linnarsson, 1876, p. 13].
Orthis aff. hicksi [Linnarsson, 1876, p. 14]=Billingsella exporrecta rugosicostata.
Billingsella lindströmi [Linnarsson, 1876, p. 12].

320q [U. S. National Museum]. (See 309j.) (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestone forming 2c of the *Paradoxides forchhammeri* zone at Alunbruk (alum works), southern part of Oeland Island, Sweden (Schmalensee, 1899).

Acrothele coriacea.
Acrothele intermedia.
Billingsella lindströmi.
Agnostus.
Dolichometopus svecicus Angelin.

320r [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones of the *Agnostus lævigatus* zone at Hunneberg, western boundary of the Province of Skaraborg, Sweden.

Acrothele coriacea.

320s [Linnarsson, 1877, p. 374]. (For stratigraphic position and association, see p. 146.) Middle Cambrian: At St. Frö, Oeland Island, Sweden.

Acrothele (Redlichella) granulata.

320t [Linnarsson, 1876, p. 24]. (For stratigraphic position and association, see p. 146.) Middle Cambrian: On the river Billstaån, parish of Hackås, Province of Jemtland, Sweden.

Acrothele (Redlichella) granulata.

320u [Linnarsson, 1876, p. 25]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Strata with *Agnostus lævigatus* at Östra Rynninge, in Nerike, Sweden.

Micromitra pusilla.

320v [Linnarsson, 1876, p. 23]. (See 320z.) (For stratigraphic position and association, see p. 145.) Middle Cambrian: In the *Paradoxides forchhammeri* zone at Lanna, Hjulsta, Vinala, and Vrana, all four in Nerike, Sweden.

Acrothele coriacea.

320w [Holm, 1898, p. 148]. (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: *Ceratopyge* limestone at Glöte, in Herjeådalen, Province of Jemtland, Sweden.

Lingulella lepis.

320x [Linnarsson, 1876, p. 16; U. S. National Museum]. (For stratigraphic position and association, see p. 146.) Lower Cambrian: In strata with *Holmia kjerulfi* at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad, Sweden.

*Lingulella nathorsti.
Holmia kjerulfi (Brögger).

320y (references follow species). (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones of the *Paradoxides forchhammeri* zone at Gudhem, 12.5 miles (20.1 km.) south-southeast of Skara, Province of Skaraborg, Sweden.

Micromitra (Iphidella) ornatella (U. S. National Museum).
Acrothele coriacea (U. S. National Museum).
Billingsella exporrecta [Linnarsson, 1876, p. 13].
Billingsella lindströmi (U. S. National Museum).

320z [Linnarsson, 1876, p. 13]. (See 320v.) (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones of the *Paradoxides forchhammeri* zone at several places in Nerike, Sweden.

Billingsella exporrecta.

321 [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlders of *Obolus* sandstone, Nos. 1, 2, 4–6, 10–16, 18–20, 22–23, 25–29, on Fanton Island, parish of Börstil, Province of Stockholm, Sweden.

Obolus apollinis.

321a [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlders of *Obolus* sandstone, Nos. 3 and 7, on Fanton Island, parish of Börstil, Province of Stockholm, Sweden.

Obolus apollinis.
Problematicum.

321b [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlder of *Obolus* sandstone, No. 8, on Fanton Island, parish of Börstil, Province of Stockholm, Sweden.

Obolus apollinis.
Hyolithes.

321c [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlder of *Obolus* sandstone, No. 17, on Fanton Island, parish of Börstil, Province of Stockholm, Sweden.

Obolus apollinis.
Obolus (Schmidtia) obtusus?.

321d [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlder of *Obolus* sandstone, No. 21, on Fanton Island, parish of Börstil, Province of Stockholm, Sweden.

Obolus apollinis.
Obolus (Schmidtia) celatus orbiculatus.

321e [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlder of *Ceratopyge* slate, No. 1, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.

Acrotreta cf. sagittalis.
Shumardia œlandica Moberg?.
Conodont.

321f [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlder of *Ceratopyge* slate, No. 2, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.

Acrotreta cf. sagittalis.
Trilobite?.

321g [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlder of *Ceratopyge* slate, No. 3, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.

Acrotreta cf. sagittalis.
Shumardia œlandica Moberg?.
Trilobite?.
Conodont.

321h [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlders of *Ceratopyge* slate, Nos. 4, 6, and 7, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.

Acrotreta cf. sagittalis.
Conodont.

321i [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Drift bowlders of *Ceratopyge* slate, Nos. 8 and 23, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.

Acrotreta cf. sagittalis.
Discina? sp.

321j [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlder of *Ceratopyge* slate, No. 9, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.

Acrotreta cf. sagittalis.
Shumardia œlandica Moberg?.
Trilobite?.
Conodont.

321k [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlder of *Ceratopyge* slate, No. 12, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.

Acrotreta cf. sagittalis.
Trilobite?.
Conodont.

321l [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlder of *Ceratopyge* slate, No. 14, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.

Lingulella lepis?.
Acrotreta cf. sagittalis.
Graptolite.

321m [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlders of *Ceratopyge* slate, Nos. 17 and 27, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.

Lingulella lepis?.
Acrotreta cf. sagittalis.
Discina sp.
Shumardia œlandica Moberg.

321n [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlder of limestone (*Ceratopyge* slate horizon) at Trödje, in Gästrikland, Sweden.

Obolella sp.
Acrotreta cf. sagittalis.
Acrotreta sp.
Orthis sp.
Graptolite.
Ceratopyge forficula Sars.
Shumardia bottnica Wiman.

321o [Wiman, 1902, p. 68]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Drift bowlder of *Obolus* sandstone, No. 9, on Fanton Island, parish of Börstil, Province of Stockholm, Sweden.

Obolus apollinis.
Lingulella sp.

321p [Wallerius, 1895, p. 67]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: In strata with *Agnostus lævigatus* at Carlfors, near the north end of Mount Billingen, Province of Wermland, Sweden.

Billingsella exporrecta.

321q [U. S. National Museum]. (See 320e.) (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones of the *Paradoxides forchhammeri* zone at Munkesten, north of Hunneberg, western boundary of the Province of Skaraborg, Sweden (Schmalensee, 1899).

Acrothele coriacea.
Acrotreta schmalenseei.
Billingsella exporrecta.

321r.[a] (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones of the *Paradoxides forchhammeri* zone at Hunneberg, western boundary of the Province of Skaraborg, Sweden.
Billingsella exporrecta.

321s [U. S. National Museum]. (For stratigraphic position and association, see p. 146.) Lower Cambrian: Brown sandstone interbedded in gray sandstone at Sularp, near Lund, Province of Malmöhus, Sweden.
Obolella lindströmi.
*Obolella mobergi.

321t [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Sandstone at Sularp, near Lund, Province of Malmöhus, Sweden.
Billingsella lindströmi.

321u [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Sandstone at Bjorkelunda, south of Simrishamn, Province of Christianstad, Sweden.
Billingsella lindströmi.

321v [U. S. National Museum]. (For stratigraphic position and association, see p. 146.) Lower Cambrian: Gray sandstone of the *Mesonacis torelli* zone at Bjorkelunda, south of Simrishamn, Province of Christianstad, Sweden.
*Obolella lindströmi.
Obolella mobergi.
Mesonacis torelli Moberg.

321x [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: *Dictyograptus* slate at Alunbruk (alum works), southern part of Oeland Island, Sweden (Schmalensee, 1899).
Obolus (Bröggeria) salteri.

321y [U. S. National Museum]. (See 8w, 310 l, and 320f.) (For stratigraphic position and association, see p. 145.) Middle Cambrian: Shale at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad, Sweden.
Acrotreta sagittalis.

321z [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Shales at Fogelsång, 5 miles (8 km.) east of Lund, Province of Malmöhus, Sweden.
Acrotreta sagittalis.

322 [U. S. National Museum]. (For stratigraphic position and association, see p. 152.) Middle Cambrian: Limestone (stratigraphic position unknown) about 6 miles (9.6 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho.
Acrotreta pyxidicula.

322a [U. S. National Museum]. (For stratigraphic position and association, see p. 152.) Middle Cambrian: Langston limestone near Paris, Bear Lake County, Idaho (R. S. Spence).
*Acrotreta idahoensis sulcata.
Microdiscus.
Ptychoparia, 2 sp.

323 [Wiman, 1902, p. 66]. (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: *Phyllograptus* slate and *Ceratopyge* limestone in the Christiania region, Norway.
Acrotreta sagittalis.

323a [Wiman, 1902, p. 66]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: *Ceratopyge* slate in the Christiania region, Norway.
Acrotreta sagittalis.
Lingulella lepis.

323b [U. S. National Museum]. (For stratigraphic position and association, see p. 146.) Middle Cambrian: Limestone of *Paradoxides œlandicus* zone at Windjuelandet, Ringsaker, Province of Hedemarken, Norway.
Acrotreta schmalenseei.

323c [Brögger, 1882, p. 44]. (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: *Ceratopyge* limestone in the Christiania region, Norway.
Lingulella lepis.

323d [Christiania University Mineral Institute collections]. (For stratigraphic position and association see p. 144.). Passage beds between the Upper Cambrian and the Ordovician: *Ceratopyge* limestone (Étage 3aγ of Brögger) at Christiania, Norway.
Acrotreta seebachi.

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[a] The authority for the citation of this locality was mislaid and could not be traced in time for insertion in this volume.

323e [Christiania University Mineral Institute collections]. (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: *Ceratopyge* limestone (Étage 3aγ of Brögger) at Engervik, in Asker, in the Christiania region, Norway.

Acrotreta seebachi.
Obolus (Bröggeria) salteri.] These may not be from the same bed.

323f [Brögger, 1882, pp. 16–17]. (A lower horizon than 323h.) (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: Lower part of the *Ceratopyge* limestone at Vestfossen, 10 miles (16.1 km.) west-southwest of Christiania, Norway.

Lingulella lepis.
Obolus (Bröggeria) salteri.
Acrotreta socialis var.?=Acrotreta seebachi.
Eoorthis christianiæ=Eoorthis daunus.
Triarthrus angelini Linnarsson.
Parabolinella rugosa Brögger.
Ceratopyge forficula Sars.
Dikellocephalus angusticauda Angelin.
Nileus limbatus Brögger.
Niobe obsoleta Linnarsson.
Amphion primigenus Angelin.
Cheirurus foveolatus Angelin.
Bellerophon (?) norvegicus Brögger.
Orthoceras atavus Brögger.

323g [Christiania University Mineral Institute collections]. (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: *Ceratopyge* limestone (Étage 3aγ of Brögger) at Vaekkerö, in the Christiania region, Norway.

Acrotreta seebachi.

323h [Brögger, 1882, p. 17]. (A higher horizon than 323f.) (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and Ordovician: Blue *Ceratopyge* limestone at Vestfossen, 10 miles (16.1 km.) west-southwest of Christiania, Norway.

Lingulella lepis.
Lingula sp.
Obolus (Bröggeria) salteri.
*Acrothele ceratopygarum (U. S. National Museum also).
Acrotreta sagittalis var.
Acrotreta socialis var.=Acrotreta seebachi.
Eoorthis christianiæ=Eoorthis daunus.
Agnostus sidenbladhi Linnarsson.
Triarthrus angelini Linnarsson.
Ceratopyge forficula Sars.
Conophrys pusilla Sars.
Dikellocephalus serratus Sars and Boeck.
Symphysurus angustatus Sars and Boeck.
Niobe insignis Linnarsson.
Niobe obsoleta Linnarsson.
Megalaspis cf. stenorachis Angelin.
Harpides rugosus Sars and Boeck.
Remopleurides dubius Linnarsson.
Holometopus (?) elatifrons Angelin.

323i [Brögger, 1882, desc. of Pl. X]. (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: *Phyllograptus* slate at Krekling, in Sandsvär, Norway.

Obolus (Bröggeria) salteri.

323j [Brögger, 1882, p. 44]. (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: *Ceratopyge* limestone at Tosterup, 7.5 miles (12 km.) north-northeast of Ystad, Province of Malmöhus, Sweden.

Obolus (Bröggeria) salteri.

323k [Brögger, 1882, p. 44]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: *Ceratopyge* slate at Tosterup, 7.5 miles (12 km.) north-northeast of Ystad, Province of Malmöhus, Sweden.

Obolus (Bröggeria) salteri.

323l (references follow species). (For stratigraphic position and association, see p. 145.) Upper Cambrian: Étage 2b at Töien, about 1 mile (1.6 km.) northeast of Christiania, Norway.

Orusia lenticularis [U. S. National Museum and Brögger, 1882, p. 48].
Parabolina spinulosa [Brögger, 1882, p. 48].

323m (references follow species). (For stratigraphic position and association, see p. 145.) Upper Cambrian: Étage 2b at Oslo, about 1 mile (1.6 km.) southeast of Christiania, Norway.

Orusia lenticularis [U. S. National Museum and Brögger, 1882, p. 4].
Parabolina spinulosa [Brögger, 1882, p. 4].

323n [Brögger, 1882, p. 48]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Étage 2b at Vestfossen, 10 miles (16.1 km.) west-southwest of Christiania, Norway.

Orusia lenticularis.
Peltura scarabæoides.

323o [Brögger, 1882, p. 4]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Etage 2b in the city of Christiania, Norway.

Orusia lenticularis.
Parabolina spinulosa.

323p (references follow species). (For stratigraphic position and association, see p. 145.) Upper Cambrian: Étage 2b at Slemmestad, in Röken, about 3 miles (4.8 km.) southwest of Christiania, Norway.
Orusia lenticularis [U. S. National Museum and Brögger, 1882, p. 4].
Parabolina spinulosa [Brögger, 1882, p. 4].

323q [Brögger, 1882, p. 101]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Étage 2b at Kårtveit, in the Christiania region, Norway.
Orusia lenticularis.
Parabolina spinulosa.

323r [Brögger, 1882, p. 4]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Étage 2b at Krekling, in Sandsvär, Norway
Orusia lenticularis.
Parabolina spinulosa.

323s [Brögger, 1882, p. 4]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Étage 2b at Gjögrefos, in Sandsvär, Norway.
Orusia lenticularis.
Parabolina spinulosa.

323t [Brögger, 1882, p. 4]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Étage 2b in Hedemarken, east of Lake Mjösen (Miösen), about 40 miles (64 km.) north-northeast of Christiania, Norway.
Orusia lenticularis.
Parabolina spinulosa.

323u [Brögger, 1882, p. 4]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Étage 2b at Öxna (Öksna), valley of Glommen River, eastern Norway.
Orusia lenticularis.
Parabolina spinulosa.

323v [Davidson, 1869, p. 231]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: At Egeberg (about 1.5 miles (2.4 km.) southeast of Christiania?), Norway.
*Orusia lenticularis.

323w (references follow species). (For stratigraphic position and association, see p. 145.) Upper Cambrian: Black argillaceous shale of "Étage 3aβ" at Christiania, Norway.
Obolus sp. (U. S. National Museum).
Obolus (Bröggeria) salteri (Univ. Mineral Inst., Christiania, Norway).
*Eoorthis wimani (U. S. National Museum).

323x [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: *Ceratopyge* slate at Russelökken, near Christiania, Norway.
*Eoorthis christianiæ.

323y [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: *Ceratopyge* slate at Töien, about 1 mile (1.6 km.) northeast of Christiania, Norway.
Eoorthis christianiæ.

323z [U. S. National Museum]. (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: *Ceratopyge* limestone at Töien, about 1 mile (1.6 km.) northeast of Christiania, Norway.
*Eoorthis daunus.

324 [Kjerulf, 1873, pp. 73 and 83]. (For stratigraphic position and association, see p. 146.) Lower Cambrian: Green shales with interbedded calcareous sandstone at Tomten, in Ringsaker, near Lake Mjösen, Province of Hedemarken, Norway.
Lingulella sp. (U. S. National Museum).
Obolella mobergi.
Obolella (Glyptias) favosa.
Holmia kjerulfi (Brögger).
Arionellus.

324a [U. S. National Museum]. (For stratigraphic position and association, see p. 146.) Middle Cambrian: Shales of Étage 1c [Brögger] at Skrena, Skiensdalen, Norway (W. C. Brögger, 1877).
Acrothele coriacea.

324b [U. S. National Museum]. (For stratigraphic position and association, see p. 146.) Middle Cambrian: Shales of Étage 1c [Brögger] at Krekling, in Sandsvär, Norway (W. C. Brögger, 1877).
Acrothele coriacea.
Agnostus nudus.

324c [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Shales of Étage 1d [Brögger] at Krekling, in Sandsvär, Norway (W. C. Brögger, 1877).

Micromitra (Iphidella) ornatella.
Acrothele coriacea.

324d.[a] (For stratigraphic position and association, see p. 145.) Middle Cambrian: At Windjuelandet, Ringsaker, Province of Hedemarken, Norway.

Lingulella ferruginea.

325 (references follow species). (For stratigraphic position and association, see p. 131.) Upper Cambrian: Arenaceous shales, possibly from the horizon of the *Peltura* fauna (Division C3b), on McAdam shore, East Bay, east of Bras d'Or Lake, in southeastern Cape Breton, Nova Scotia.

*Obolus (Westonia) escasoni [Matthew, 1903, p. 208].
*Agnostus trisectus germanus [Matthew, 1903, p. 221].
*Agnostus trisectus ponepunctus [Matthew, 1903, p. 221].
*Sphærophthalmus fletcheri [Matthew, 1903, p. 228].
Ctenopyge pecten [Matthew, 1903, p. 230].
Parabolina dawsoni [Matthew, 1903, p. 224].
Peltura scarabæoides [Matthew, 1903, p. 230].

325a (references follow species). (For stratigraphic position and association, see p. 131.) Middle Cambrian: Shales of Division C2c of Matthew's [1903, p. 49] Bretonian on the eastern slope of the valley of McNeil Brook, on the road to Trout Brook, in the Mira River valley, eastern Cape Breton, Nova Scotia.

*Lingulella flumenis [Matthew, 1903, p. 190].
*Lingulella rotunda [Matthew, 1903, p. 199].
*Acrotreta cf. socialis [Matthew, 1903, p. 184]=Acrotreta sp. undt.

325b [Matthew, 1903, desc. of Pl. XV]. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Sandy shales of Division C3a of Matthew, Escasonie shore, East Bay, east of Bras d'Or Lake, in southeastern Cape Breton, Nova Scotia.

*Lingulella lævis grandis.

325c [U. S. National Museum]. (For stratigraphic position and association, see p. 132.) Middle Cambrian: Sandstone on the shore of Bras d'Or Lake, eastern Cape Breton, Nova Scotia.

Lingulella rotunda.

326 [U. S. National Museum]. Lower Ordovician: Limestone pebbles on the beach on the northern shore of Marthas Vineyard, Mass.

Obolus (Westonia) rogersi.
Lingulella bella.

326a [Grabau, 1900, p. 613]. Lower Ordovician: Limestone pebbles in a Carboniferous conglomerate north of Fall River, Bristol County, Mass.

Obolus (Westonia) rogersi.
Obolus (Lingulobolus) affinis.
Obolus (Lingulobolus) spissus.
Scolithus linearis Haldemann.

326b [Grabau, 1900, p. 617]. Middle Cambrian: Braintree slate, below high tide, about 100 feet (30.5 m.) east of the quarry at East Braintree, Abington quadrangle (U. S. G. S.), Norfolk County, Mass.

*Acrothele gamagei.

326c [Boston Society Natural History; casts in U. S. National Museum]. Lower Cambrian: "Nahant limestone," Pulpit Rock, Nahant, Essex County, Mass.

*Acrothele woodworthi.

326d [Grabau, 1900, p. 610]. Lower Cambrian: "Station 2," near North Attleboro, Bristol County, Mass.

Obolella atlantica.
Obolella crassa.
Scenella reticulata Billings.
Platyceras primævum Billings.
Stenotheca abrupta (Shaler and Foerste).
Stenotheca curvirostra (Shaler and Foerste).
Hyolithes quadricostatus (Shaler and Foerste).
Hyolithes americanus Billings.
Orthotheca emmonsi (Ford).
Aristozoe?.
Olenellus walcotti (Shaler and Foerste).
Microdiscus bellimarginatus (Shaler and Foerste).
Microdiscus lobatus (Hall).
Strenuella strenua (Billings).
Ptychoparia? attleborensis (Shaler and Foerste).

326e [Grabau, 1900, p. 610]. Lower Cambrian: Dark purplish siliceous shales on Pearl Street, North Weymouth, Norfolk County, Mass.

Obolella atlantica.
Urotheca pervetus Matthew.
Olenellus (Holmia) bröggeri (Walcott)=Callavia crosbyi Walcott.
Olenellus sp. Burr=Callavia burri Walcott.
Olenellus (Mesonacis) asaphoides Emmons?=Callavia crosbyi Walcott.
Metadoxides magnificus? Matthew=Callavia crosbyi Walcott.
Microdiscus cf. helena Walcott.
Strenuella strenua (Billings).
Trails.

[a] The authority for the citation of this locality was mislaid and could not be traced in time for insertion in this volume.

326f (references follow species). Lower Cambrian: One-half mile (0.8 km.) south of North Weymouth [Burr, 1900, p. 42], Norfolk County, Mass.

Obolella atlantica [Burr, 1900, p. 47].
Obolella sp. [Burr, 1900, p. 48].
Olenellus (Holmia) bröggeri [Burr, 1900, p. 43]=Callavia crosbyi Walcott.
Olenellus (Mesonacis) asaphoides [Burr, 1900, p. 45]=Callavia crosbyi Walcott.
Olenellus sp. [Burr, 1900, p. 45]=Callavia burri Walcott.
Metadoxides magnificus? [Burr, 1900, p. 46]=Callavia crosbyi Walcott.
Agraulos (Strenuella) strenuus nasutus [Burr, 1900, p. 46].
Microdiscus cf. helena [Burr, 1900, p. 47].
Leperditia cf. solitaria [Burr, 1900, p. 47].
Urotheca pervetus [Burr, 1900, p. 48].
Orthotheca cylindrica [Burr, 1900, p. 48].

326g (references follow species). Lower Cambrian: Limestones at East Point, Nahant, Essex County, Mass.

Micromitra (Paterina) bella [Grabau, 1900, p. 618].
Obolella crassa [Grabau, 1900, p. 620].

327 [U. S. National Museum]. Upper Cambrian: Arenaceous limestone east of Gold Camp, Caballos Mountains, Sierra County, N. Mex. (W. T. Lee, 1905).

Obolus sinoe.
Obolus sinoe?.
Obolus (Westonia) stoneanus.
Lingulella acutangula?.
Eoorthis desmopleura.

327a [U. S. National Museum]. Upper Cambrian: Arenaceous limestone about 500 feet (152 m.) above the base of the Cambrian, in McKinley Canyon, Caballos Mountains, Sierra County, N. Mex. (W. T. Lee, 1905).

Obolus (Westonia) stoneanus.

327b [U. S. National Museum]. Upper Cambrian: Arenaceous limestone near the base of the section on the south side of Cerro Cuchillo, Caballos Mountains, Sierra County, N. Mex. (W. T. Lee, 1905).

Obolus (Westonia) stoneanus.

327c [U. S. National Museum]. Upper Cambrian: Arenaceous limestone in the Caballos Mountains, Sierra County, N. Mex. (W. Lindgren, 1905).

Obolus (Westonia) stoneanus.

328 [Whitfield, 1882, p. 172]. Upper Cambrian: Upper layers of the "St. Croix sandstone" near the north end of Devils Lake, Sauk County, Wis.

*Syntrophia barabuensis.

328a [U. S. National Museum]. Upper Cambrian: "St. Croix sandstone" 4 miles (6.4 km.) north of Winfield, Jefferson County, Wis.

Lingulella similis.

328b [Sardeson, 1896, p. 95]. Upper Cambrian: St. Lawrence formation at Osceola, Polk County, Wis.

Obolus (Westonia) aurora.

328c [U. S. National Museum]. Upper Cambrian: "St. Croix sandstone" at Alma, Buffalo County, Wis.

Dicellomus politus.
Billingsella coloradoensis.
Ptychoparia diademata (Hall).

328d [Whitfield, 1882, p. 171]. Upper Cambrian: "St. Croix sandstone" at Berlin, Green Lake County, Wis.

Billingsella coloradoensis.

328e [U. S. National Museum]. Middle Cambrian: "St. Croix sandstone" at St. Croix Falls, Polk County, Wis. (See p. 159.)

Obolus matinalis.
Lingulella (Lingulepis) acuminata.
*Acrotreta signalis.

328f [Hall, 1863, p. 128]. Upper Cambrian: Sandstone at the falls of St. Croix River, Polk County, Wis.

Obolus (Westonia) stoneanus.

328g (references follow species). Middle Cambrian: "St. Croix sandstone," Wisconsin shore of Mississippi River, near Trempealeau, Trempealeau County, Wis. (See p. 159.)

Lingulella ampla (U. S. National Museum).
Dicellomus politus [Hall, 1863, p. 134].
Conocephalites ioweusis [Hall, 1863, p. 134].
Conocephalites chippewaensis [Hall, 1863, p. 134].
Hyolithes primordialis [Hall, 1863, p. 134].

328h [Owen, 1852, p. 583, and U. S. National Museum]. Upper Cambrian: Silico-calcareous layers of F1b of Owen's section at the falls of the St. Croix, Polk County, Wis.

*Obolus matinalis.
Lingulella (Lingulepis) acuminata.

328i [U. S. National Museum]. Upper Cambrian: "St. Croix sandstone" 0.33 mile (0.5 km.) west of the railway station, Lodi, Columbia County, Wis.
Finkelnburgia osceola.

328j [U. S. National Museum]. Upper Cambrian: "St. Croix sandstone" on Willow River, near Hudson, St. Croix County, Wis.
Obolus mickwitzi.

328k [Whitfield, 1877, p. 51]. Upper Cambrian: "St. Croix sandstone" at Roche à Cris Bluff, Adams County, Wis.
*Syntrophia primordialis.

328l [U. S. National Museum]. (See 328i.) Upper Cambrian: "St. Croix sandstone" near Lodi, Columbia County, Wis.
Obolus (Westonia) aurora.

328m [U. S. National Museum]. Upper Cambrian: Sandstone 1 mile (1.6 km.) south of Osceola, Polk County, Wis. (F. W. Sardeson, 1891).
Obolus (Westonia) stoneanus.

328n [U. S. National Museum]. Upper Cambrian: "St. Croix sandstone" 2 miles (3.2 km.) south of Osceola, Polk County, Wis.
Lingulella similis.

328p [U. S. National Museum]. (See 85x.) Upper Cambrian: "St. Croix sandstone" at Mazomanie, Dane County, Wis. (J. Hall).
Obolus (Westonia) aurora.

328q [U. S. National Museum]. Upper Cambrian: "St. Croix sandstone" in quarry at Ableman, Sauk County, Wis. (J. F. James, 1889).
Eoorthis remnicha.

329 [Hague, 1877, p. 405]. (For stratigraphic position and association, see p. 149.) Middle Cambrian: Green shales in a canyon about 7 miles (11.2 km.) north of Brigham (near the village of "Calls Fort" [Hague, 1877, p. 405]), Boxelder County, Utah.
*Obolus (Westonia) ella.
Olenoides wasatchensis (Hall and Whitfield).
Ptychoparia quadrans (Hall and Whitfield).
Dikellocephalus gothicus=Olenoides wasatchensis.

329a [U. S. National Museum]. (For stratigraphic position and association, see p. 148.) Upper Cambrian: Limestone on Ute Peak, in the Wasatch Mountains, east of Cache Valley, Cache County, Utah.
Syntrophia nundina?.

329b [U. S. National Museum]. (For stratigraphic position and association, see p. 155.) Middle Cambrian: Thin-bedded limestone collected by the Wheeler survey in Utah.
Dicellomus politus.

329c [U. S. National Museum]. (For stratigraphic position and association, see p. 151.) Middle Cambrian: In Weber Canyon, about 2.5 miles (4 km.) northeast of Peterson, Morgan County, Utah.
Obolus (Westonia) ella.

329d [U. S. National Museum]. (For stratigraphic position and association, see p. 154.) Upper Cambrian: Limestone near Fish Spring, Fish Spring Range, Juab County, Utah.
Acrotreta pyxidicula.

329e [U. S. National Museum]. (For stratigraphic position and association, see p. 158.) Middle Cambrian: Shales in East Canyon, above Ophir, Oquirrh Range, Tooele County, Utah (40th Parallel Survey).
Obolus (Westonia) ella.

330 [Hall, 1851, p. 204]. Upper Cambrian: Sandstone on Taquamenon Bay, Chippewa County, Mich.
Lingulella (Lingulepis) acuminata.

330a [Hall, 1851, p. 204]. Upper Cambrian: Sandstone on Escanaba River, northern Michigan.
Lingulella (Lingulepis) acuminata.

330b [U. S. National Museum]. Upper Cambrian: Sandstone at Iron Mountain, Dickinson County, Mich. (W. S. Bayley, 1902).
Lingulella (Lingulepis) acuminata.

331 [U. S. National Museum]. Upper Cambrian: Rogersville shale 1 mile (1.6 km.) south of Fletcher, Russell County, Va.
Obolus lamborni?

332 [Kayser, 1883, p. 35]. Upper Cambrian: Limestone at Saimaki, Liaotung, China.
*Obolus? sp. undt. f.
Lingulella davisi.

332a [Kayser, 1883, p. 34]. Upper Cambrian: At Taling, Liaotung, China.
*Eoorthis linnarssoni.

333 (references follow species). (For stratigraphic position and association, see p. 158.) Middle Cambrian: Shales on the dump of the Abe Lincoln mine, near Pioche, Lincoln County, Nev.
Micromitra pannula [Pack, 1906, p. 296].
Obolus (Westonia) ella [Pack, 1906, p. 295].
Lingulella genei [Pack, 1906, p. 295]=Lingulella dubia.
Eocystites longidactylus [Pack, 1906, p. 294].
Bathyuriscus howelli [Pack, 1906, p. 297].
Bathyuriscus productus [Pack, 1906, p. 297].
Zacanthoides typicalis [Pack, 1906, p. 299].

333a (references follow species). (For stratigraphic position and association, see p. 158.) Middle Cambrian: Shales on the dump of the Himon mine, near Pioche, Lincoln County, Nev.
Obolus (Westonia) ella [Pack, 1906, p. 295].
Bathyuriscus howelli [Pack, 1906, p. 297].
Bathyuriscus productus [Pack, 1906, p. 297].
Ptychoparia piochensis [Pack, 1906, p. 298].

333b (references follow species). (See 7k.) (For stratigraphic position and association, see p. 158.) Middle Cambrian: Shales on the dump of the Half-moon mine, near Pioche, Lincoln County, Nev.
Obolus (Westonia) ella [Pack, 1906, p. 295].
Bathyuriscus howelli [Pack, 1906, p. 297].
Ptychoparia piochensis [Pack, 1906, p. 298].
Ptychoparia kempi [Pack, 1906, p. 298].
Zacanthoides typicalis [Pack, 1906, p. 299].
Zacanthoides grabaui [Pack, 1906, p. 300].

334 (references follow species). (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones of *Paradoxides forchhammeri* zone on Bornholm Island, Denmark.
Acrotreta socialis [Wallerius, 1895, p. 66]=Acrotreta schmalenseei.
Acrotreta socialis [Linnarsson, 1876, p. 18]=Acrotreta schmalenseei.

334a [Grönwall, 1902, p. 39]. (For stratigraphic position and association, see p. 146.) Middle Cambrian: Limestones of the *Conocoryphe exsulans* zone at Borregaard, Bornholm Island, Denmark.
Acrothele intermedia.

334b [Grönwall, 1902, p. 40]. (For stratigraphic position and association, see p. 145. Middle Cambrian: Andrarum limestone at Borregaard, Bornholm Island, Denmark.
Acrothele coriacea.

334c [Grönwall, 1902, p. 40]. (For stratigraphic position and association, see p. 146.) Middle Cambrian: In the *Paradoxides tessini* zone at Borregaard, Bornholm Island, Denmark.
Acrothele coriacea.

334d [Grönwall, 1902, p. 40]. (For stratigraphic position and association, see p. 146.) Middle Cambrian: In the zone with *Agnostus parvifrons* at Borregaard, Bornholm Island, Denmark.
Acrothele coriacea.

334e [Grönwall, 1902, p. 40]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Andrarum limestone at Laesaå, Bornholm Island, Denmark.
Acrothele coriacea.

334f [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestone on Bornholm Island, Denmark.
Acrothele coriacea.

334g [Seebach, 1865, pp. 340 and 341]. (For stratigraphic position and association, see p. 145.) Middle Cambrian: On Bornholm Island, Denmark.
*Acrotreta socialis.
Paradoxides.
Agnostus pisiformis Linnarsson.
Agnostus bituberculatus.
Agnostus? punctuosus.
Anomocare difforme Angelin.

334h [U. S. National Museum]. (See 16h.) (For stratigraphic position and association, see p. 145.) Middle Cambrian: Limestones of the *Paradoxides forchhammeri* zone at Borregaard, Bornholm Island, Denmark (University of Copenhagen).
Acrothele coriacea.
Acrotreta sagittalis.

335a. [U. S. National Museum]. (See 360b.) Passage beds between the Cambrian and the Ordovician: Reddish sandstone on Cement Creek, 3 miles (4.8 km.) north of Hot Springs and 8 to 10 miles (12.8 to 16.1 km.) southeast of Crested Butte, Ouray County, Colo.
*Obolus loperi.

336 [F. Schmidt, personal communication, 1906]. (For stratigraphic position and association, see p. 143.) Ordovician: *Echinosphærites* limestone, horizon Cla, at Popowka, near St. Petersburg, Russia.

*Acrotreta subconica.

336a (references follow species). (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone at Podolova (Putalova?), on Ijora (Ischora) River, Government of St. Petersburg, Russia.

Obolus apollinis [Eichwald, 1860, p. 926].
Obolus apollinis ingricus [Eichwald, 1860, p. 926].
Keyserlingia buchi [Eichwald, 1860, p. 914].

336b [Eichwald, 1860, p. 925]. (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstones on Odensholm Island, about 55 miles (88.6 km.) west of Reval, Government of Esthonia, Russia.

Obolus apollinis.

336c [Eichwald, 1860, p. 926]. (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone at Reval, Government of Esthonia, Russia.

Obolus apollinis.
Obolus apollinis ingricus.

336d [Eichwald, 1860, p. 929]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: *Orthoceratite* limestone at Reval, Government of Esthonia, Russia.

Obolus (Acritis) antiquissimus.

336e (references follow species). (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: *Orthoceratite* limestone, at Pulkowa, near St. Petersburg, Russia.

Obolus (Acritis) antiquissimus [Eichwald, 1860, p. 929].
Siphonotreta unguiculata [Eichwald, 1860, p. 916].
Siphonotreta verrucosa [Eichwald, 1860, p. 916].

336f [Eichwald, 1860, p. 927]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: In the pyroxene-bearing sands in the *Orthoceratite* limestone beds at Reval, Government of Esthonia, Russia.

Obolus (Mickwitzella) siluricus.

336g (references follow species). (For stratigraphic position and association, see p. 143.) Ordovician: Limestone in the vicinity of Zarskoe Selo, Government of St. Petersburg, Russia.

*Volborthia recurva [Kutorga, 1848, p. 278].
Siphonotreta unguiculata [Kutorga, 1848, p. 265].
} These species may not be from the same bed.

336h [U. S. National Museum]. (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Ungulite* grit at Baltischport, Esthonia, Russia.

*Schizambon? esthonia.

336i [Mickwitz, 1896, p. 147]. (For stratigraphic position and association, see p. 144.) Upper Cambrian: Sandstone below the *Obolus* conglomerate proper at Reval, Government of Esthonia, Russia.

Obolus triangularis.

336j [U. S. National Museum]. (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone at Staroja Ladoga, Government of Novgorod, Russia.

Obolus apollinis maximus.

336k [Eichwald, 1860, p. 925]. (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone on the bank of Volkhof (Wolchow) River, east of St. Petersburg, Russia.

Obolus apollinis.

336l [Eichwald, 1860, p. 925]. (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone on the bank of Sjass (Sias) River, near Lake Ladoga, Government of St. Petersburg, Russia.

Obolus apollinis.

336m [Eichwald, 1860, p. 925]. (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone at Baltischport, about 30 miles (48 km.) west of Reval, Government of Esthonia, Russia.

Obolus apollinis.

336n [de Verneuil, 1845, p. 289]. (For stratigraphic position and association, see p. 143.) Upper Cambrian: On Ijora (Ischora) River, Government of St. Petersburg, Russia.

*Keyserlingia buchi.

336o [U. S. National Museum]. (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Ungulite* grit, Koporje, Government of St. Petersburg, Russia.

Obolus (Schmidtia) celatus.
Helmersenia ladogensis.
Keyserlingia buchi.

336p [U. S. National Museum]. (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Ungulite* grit, Kunitz, Government of Pskow, Russia.

Obolus (Schmidtia) celatus.
Obolus sp.
Helmersenia ladogensis.
Keyserlingia buchi.

336q [Jeremejew, 1856, pp. 73 and 80]. (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Ungulite* sandstone near Ladoga, Government of St. Petersburg, Russia.

*Helmersenia ladogensis.

336r [Mickwitz, 1896, p. 137]. (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone in the entire region between the Volkhof (Wolchow) and Sjass (Sias) rivers on the east and Baltischport on the west, governments of Novgorod, St. Petersburg, and Esthonia, Russia.

Obolus apollinis.

336s (references follow species). (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone at Narwa, Government of Esthonia, Russia.

Obolus apollinis (U. S. National Museum).
Obolus apollinis ingricus [Eichwald, 1843, p. 146].

336t [Eichwald, 1843, p. 146]. (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone at Wiems, 5 miles (8 km.) north-northeast of Reval, Government of Esthonia, Russia.

Obolus apollinis.
Obolus apollinis ingricus.

336u [Eichwald, 1860, p. 925]. (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone on the bank of Louga (Luga) River, southwest of St. Petersburg, Russia.

Obolus apollinis.

336v [Gagel, 1890, desc. of Pl. I]. (For stratigraphic position and association, see p. 143.) Ordovician: *Echinosphærites* limestone at Reval, Government of Esthonia, Russia.

Siphonotreta unguiculata.

336w (references follow species). (For stratigraphic position and association, see p. 143.) Ordovician: Near Pawlowsk, near St. Petersburg, Russia.

Siphonotreta unguiculata [Eichwald, 1840, p. 140 (26)].
Siphonotreta verrucosa [Eichwald, 1840, p. 141 (27)].

336x [de Verneuil, 1845, p. 287]. (For stratigraphic position and association, see p. 143.) Ordovician: In the Archangel quarry, on Volkhof (Wolchow) River, east of St. Petersburg, Russia.

Siphonotreta unguiculata.

336y [U. S. National Museum]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: Glauconite limestone at Popowka, near St. Petersburg, Russia.

Siphonotreta unguiculata.
Siphonotreta verrucosa.

336z [Schmidt, 1861, pp. 218 and 248]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: *Orthoceratite* limestone ("Vaginatenkalk") at Narwa, Government of Esthonia, Russia.

Siphonotreta unguiculata.

337 [Schmidt, 1861, pp. 218 and 248]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: *Orthoceratite* limestone ("Vaginatenkalk") at Erras, 85 miles (137 km.) east of Reval, Government of Esthonia, Russia.

Siphonotreta unguiculata.

337a [Schmidt, 1861, pp. 218 and 248]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: *Orthoceratite* limestone ("Vaginatenkalk") at Kusal, 25 miles (40 km.) east of Reval, Government of Esthonia, Russia.

Siphonotreta unguiculata.

337b [Schmidt, 1861, pp. 218 and 248]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: *Orthoceratite* limestone ("Vaginatenkalk") at Reval, Government of Esthonia, Russia.

*Siphonotreta unguiculata.[a]

337c [Schmidt, 1861, pp. 218 and 248]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: *Orthoceratite* limestone ("Vaginatenkalk") on Odensholm Island, 55 miles (88.6 km.) west of Reval, Government of Esthonia, Russia.

Siphonotreta unguiculata.

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[a] May be the type locality. Eichwald [1829, p. 274] gives it as "limestone at Reval."

337d [Schmidt, 1861, p. 218]. (For stratigraphic position and association, see p. 143.) Ordovician: "Brandschiefer" at Salla, near Erras, 85 miles (137 km.) east of Reval, Government of Esthonia, Russia.
Siphonotreta unguiculata.

337e [Schmidt, 1861, p. 218]. (For stratigraphic position and association, see p. 143.) Ordovician: "Jewesche Schicht" at Altenhof, near Pöddrus, 55 miles (88.6 km.) east of Reval, Government of Esthonia, Russia.
Siphonotreta unguiculata.

337f [Schmidt, 1861, pp. 218 and 248]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: *Orthoceratite* limestone ("Vaginatenkalk") at Türsel, 15 miles (24.2 km.) west of Narwa, Government of Esthonia, Russia.
Siphonotreta verrucosa.

337g [Schmidt, 1861, pp. 218 and 248]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: *Orthoceratite* limestone ("Vaginatenkalk") at Chudleigh, 25 miles (40 km.) west of Narwa, Government of Esthonia, Russia.
Siphonotreta verrucosa.

337h [Eichwald, 1860, p. 929]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: *Orthoceratite* limestone near Reval, Government of Esthonia, Russia.
Obolus (Acritis) antiquissimus.

337i [Schmidt, 1861, p. 218]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: "Green sand" at Baltischport, Government of Esthonia, Russia.
Obolus (Mickwitzella) siluricus.

337j [Fr. Schmidt, personal communication, 1908]. (For stratigraphic position and association, see p. 143.) Ordovician: Zone BIIIα or BIIIβ, characterized by *Asaphus raniceps*, a little above the zone with *Asaphus expansus*, in the *Orthoceratite* limestone at Obookhov (Obuchow), on Volkhof (Wolchow) River, Government of St. Petersburg, Russia.
Volborthia recurva.

337k [Eichwald, 1860, p. 916]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: *Orthoceratite* limestone on the banks of Volkhof (Wolchow) River, near Lake Ladoga, near St. Petersburg, Russia.
Siphonotreta unguiculata.

337l [Eichwald, 1860, p. 916]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: *Orthoceratite* limestone at Baltischport, west of Reval, Government of Esthonia, Russia.
Siphonotreta unguiculata.

337m [Eichwald, 1860, p. 916, and U. S. National Museum]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: *Orthoceratite* limestone at Popowka, near St. Petersburg, Russia.
Siphonotreta unguiculata.
Siphonotreta verrucosa.

338 [U. S. National Museum]. (See 29a.) Lower Cambrian: Limestone at Schodack, northeastern corner of Coxsackie quadrangle (U. S. G. S.), Rensselaer County, N. Y.
Acrotreta sagittalis taconica.

338a [U. S. National Museum]. Lower Cambrian: Limestone in the northeast section of Whitehall township, Whitehall quadrangle (U. S. G. S.), Washington County, N. Y.
Acrotreta sagittalis taconica.

338b [U. S. National Museum]. (See 29.) Lower Cambrian: Limestone on Kinderhook Creek, near Stockport paper mill, Kinderhook quadrangle (U. S. G. S.), Columbia County, N. Y.
Acrotreta sagittalis taconica.

338c [U. S. National Museum]. (See 33.) Lower Cambrian: Limestone at Rock Hill schoolhouse, near North Greenwich, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y.
Acrotreta sagittalis taconica.

338d [U. S. National Museum]. (See 36; may be same locality.) Lower Cambrian: Limestone 1 mile (1.6 km.) south of Shushan, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y.
Acrotreta sagittalis taconica.
Billingsella salemensis. } These species may not occur in the same bed.

338e [U. S. National Museum]. Lower Cambrian: Limestone a little west of North Greenwich, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y.
Acrotreta sagittalis taconica.

338f [U. S. National Museum]. Lower Cambrian: Limestone near Argyle, 8 miles (12.8 km.) north of Greenwich, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y.
Acrotreta sagittalis taconica.

338g [U. S. National Museum]. Lower Cambrian: Limestone in the town of Greenwich, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y.
Acrotreta sagittalis taconica.

338h [U. S. National Museum]. (See Walcott, 1888, pp. 316 and 317, for section.) Lower Cambrian: Limestone on the summit of Bald Mountain, about 2 miles (3.2 km.) northwest of Greenwich, Schuylerville quadrangle (U. S. G. S.), Washington County, N. Y.
Botsfordia cælata.
Acrotreta sagittalis taconica.
Obolella sp.
Hyolithellus micans (Billings).
Microdiscus speciosus Ford.
Olenellus thompsoni (Hall).

338i [U. S. National Museum]. Ordovician: Shales 1 mile (1.6 km.) west-northwest of South Argyle, near the line between the Schuylerville and Cambridge quadrangles (U. S. G. S.), Washington County, N. Y
Acrothele pretiosa.

338j [Hall, 1847, p. 4]. Upper Cambrian: Potsdam sandstone near Alexandria Landing, Jefferson County, N. Y.
Lingulella (Lingulepis) acuminata.

338k [U. S. National Museum]. (See 72a.) Lower Cambrian: Limestone 2.5 miles (4 km.) southwest of Wynantskill, Rensselaer County, N. Y. (L. M. Prindle, 1893).
Obolus prindlei.

338l [U. S. National Museum]. (See 39a.) Lower Cambrian: Limestone in the northern part of Easton, 3 miles (4.8 km.) south of Greenwich, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y.
Lingulella granvillensis.

338m [U. S. National Museum]. Lower Cambrian: Limestone on the roadside north of schoolhouse No. 4, in the northeast part of Whitehall, Whitehall quadrangle (U. S. G. S.), Washington County, N. Y.
Lingulella granvillensis.

338n [U. S. National Museum]. Lower Cambrian: Western belt of conglomeratic limestone, Rensselaer County, N. Y.
Yorkia washingtonensis.
Microdiscus lobatus (Hall).

338o [?]. Lower Cambrian: Shale on Moses Hill, 2 miles (3.2 km.) west of North Greenwich, near the line between the Schuylerville and Cambridge quadrangles (U. S. G. S.), Washington County, N. Y.
Obolella crassa.

338p [U. S. National Museum]. Lower Cambrian: Sandy limestone 0.25 mile (0.4 km.) northwest of schoolhouse No. 7, in Greenwich, Cambridge quadrangle (U. S. G. S.), Washington County, N.Y.
Obolella chromatica.

338q [Hall, 1847, p. 290]. Lower Cambrian: Calcareous beds 2 miles (3.2 km.) northeast of Troy, Troy quadrangle (U. S. G. S.), Rensselaer County, N. Y.
*Obolella crassa.

338r [Billings, 1856, p. 34]. Upper Cambrian: Potsdam sandstone at Keeseville, Essex County, N. Y.
Lingulella (Lingulepis) acuminata.

338s [Emmons, 1842, pp. 267 and 268]. Upper Cambrian: Potsdam sandstone at High Bridge, on Ausable River, Essex County, N. Y.
*Lingulella (Lingulepis) acuminata.

338t [U. S. National Museum records]. Upper Cambrian: Potsdam sandstone in Ausable Chasm, below Keeseville, Essex County, N. Y.
Lingulella prima.
Lingulella (Lingulepis) acuminata.

338u [U. S. National Museum records]. Ordovician and Upper Cambrian: In the strata from the upper layers of the Potsdam sandstone to the lower portion of the "Calciferous sand rock" at Chateaugay Falls, Franklin County, N. Y.
Lingulella (Lingulepis) acuminata (associated with Ophileta complanata in the upper beds).

338v [U. S. National Museum]. Ordovician: Shale 1 mile (1.6 km.) southwest of Middle Granville, Mettawee quadrangle (U. S. G. S.), Washington County, N. Y.
*Obolus sp. undt. a.

338w [Hall, 1847, p. 4]. Upper Cambrian: Potsdam sandstone at Hammond, St. Lawrence County, N. Y.
Lingulella (Lingulepis) acuminata.

338x [U. S. National Museum]. Lower Cambrian: Limestone 0.5 mile (0.8 km.) south of Coila, just east of Cambridge, Cambridge quadrangle (U. S. G. S.), Washington County, N. Y. (C. D. Walcott, 1886).
Lingulella sp.
Acrotreta sagittalis taconica.

338y [U. S. National Museum]. Lower Cambrian: Limestone north of Eagle Mills, Rensselaer County, N. Y. (T. N. Dale).
Acrotreta sagittalis taconica.

338z [U. S. National Museum]. Ordovician: Limestone on the north side of Bald Mountain, about 2 miles (3.2 km.) northwest of Greenwich, Schuylerville quadrangle (U. S. G. S.), Washington County, N. Y. (F. H. Moffit, 1902).
Acrothele pretiosa.

339 [Sardeson, 1896, pp. 95 and 96]. Lower Ordovician: Oneota dolomite, Stillwater, Washington County, Minn.
*Obolus dolatus.
Orthis (Billingsella) pepina=Billingsella coloradoensis.

339a [Sardeson, 1896, p. 95]. Upper Cambrian: St. Lawrence formation at Otisville, Washington County, Minn.
Obolus (Westonia) aurora.

339b [U. S. National Museum]. Upper Cambrian: "St. Croix sandstone" at Arcola on St. Croix River, 7 miles (11.2 km.) above Stillwater, Washington County, Minn.
Lingulella winona.

339c [U. S. National Museum]. Upper Cambrian: Reeds Landing, foot of Lake Pepin, Wabasha County, Minn.
Obolus (Westonia) aurora.

339d [U. S. National Museum]. (See 82b; may be same locality.) Upper Cambrian: "St. Croix sandstone" at Taylors Falls, Chisago County, Minn.
Obolus matinalis.
Lingulella similis.
Eoorthis remnicha sulcata.
Syntrophia primordialis.

339e [U. S. National Museum]. Middle Cambrian: "St. Croix sandstone" on Mountain Island, Minnesota, in Mississippi River, just above the mouth of Trempealeau River. (See p. 159.)
*Lingulella ampla.
Dicellomus politus.

339f [U. S. National Museum]. Upper Cambrian: "St. Croix sandstone" near Minneiska (Miniska), on Mississippi River, near the line between Wabasha and Winona counties, Minn. (F. M. Brown).
Obolus matinalis.
Billingsella coloradoensis.
Fiukelnburgia finkelnburgi.

339g [U. S. National Museum]. Upper Cambrian: "St. Croix sandstone" just below the beds with *Dikellocephalus minnesotensis* near Winona, Winona County, Minn.
Billingsella coloradoensis.
Finkelnburgia osceola.
Finkelnburgia osceola corrugata.
Syntrophia primordialis.

339h (references follow species). Upper Cambrian: "St. Croix sandstone" near the mouth of Minneiska (Miniska) River, near the line between Wabasha and Winona counties, Minn.
Obolus matinalis [Hall, 1863, p. 130].
Lingulella (Lingulepis) acuminata [Hall, 1863, p. 130].
Orthis pepina [Hall, 1863, p. 135]=Billingsella coloradoensis.

339i [Owen, 1852, desc. of Pl. IB]. Middle Cambrian: Sandstones of F1b of Owen's section, below Mountain Island, in Mississippi River, nearly opposite the old mouth of Black River, southeastern Minnesota. (See p. 159.)
*Dicellomus politus.

339j [U. S. National Museum]. Middle Cambrian: Sandstone between the lowest blue shale and the reddish calcareous beds above, at Taylors Falls, Chisago County, Minn. (Chas. Schuchert). (See p. 159.)
Lingulella (Lingulepis) acuminata.

339k [U. S. National Museum]. Middle Cambrian: Sandstone near Winona, Winona County, Minn. (See p. 159.)
Lingulella (Lingulepis) acuminata.

340 [U. S. National Museum]. (See 5f.) Middle Cambrian: Limestone in Meagher County, on the road to Wolsey, about 1 mile (1.6 km.) below the divide and 13 miles (21 km.) south of Neihart, Little Belt Mountains quadrangle (U. S. G. S.), Cascade County, Mont. (W. H. Weed, F. B. Weeks, and C. D. Walcott, 1895).
Micromitra pealei.

340a [U. S. National Museum]. (Same horizon as 4n.) Middle Cambrian: Shales near Helena, Jefferson County, Mont. (L. S. Griswold).
Obolus (Westonia) ella.

340b [U. S. National Museum]. Upper Cambrian: Limestone at the mouth of Fourmile Creek, probably somewhere in the Threeforks quadrangle (U. S. G. S.), Gallatin County, Mont. (A. C. Peale).
Eoorthis desmopleura.

340c [U. S. National Museum]. Middle? Cambrian: Dark-red sandstone near the base of the Cambrian at Rawlins, Carbon County, Wyo. (N. H. Darton).
Lingulella (Lingulepis) acuminata.

340d [U. S. National Museum]. Middle Cambrian: Limestone near the head of Bear River Canyon, Wyo. (A. C. Peale).
Acrotreta attenuata.

340e [U. S. National Museum]. Middle? Cambrian: Shale on the west side of Cable Mountain, Phillipsburg quadrangle (U. S. G. S.), Granite County, Mont. (F. C. Calkins, 1906).
Lingulella sp.

340f [U. S. National Museum]. Middle? Cambrian: Lowest beds exposed at the mouth of Bear Creek, Little Belt Mountains, Mont. (W. H. Weed, 1894).
Dicellomus politus.

341 [U. S. National Museum]. Upper Cambrian: Near Lansing, Allamakee County, Iowa.
*Lingulella winona (also cited from this locality by Hall, 1863, p. 126).
Finkelnburgia osceola.

341a [U. S. National Museum]. Upper Cambrian: Sandstone at McGregor, Clayton County, Iowa (F. W. Sardeson, 1899).
Lingulella mosia.

342 [collection of J. Miquel]. Middle Cambrian: Shales in Montagne Noire, Coulouma, Department of Hérault, France.
*Acrothele bergeroni.

342a [collection of J. Miquel]. Passage beds between the Cambrian and the Ordovician, or Lower Ordovician: Barren quartzitic beds, Coulouma, Department of Hérault, France.
*Yorkia? miqueli.

343 [Rogers, 1875, p. 11, mentions specimens from Newport; U. S. National Museum has specimens labeled Narragansett Bay]. Lower Ordovician: Limestone pebbles on the beach near Newport and at several points along the shores of Narragansett Bay, Rhode Island.
*Obolus (Westonia) rogersi.

343a [U. S. National Museum]. Upper Cambrian: Limestone pebbles on Checker Beach, near Newport, R. I. (O. O. Nylander, 1893).
Lingulella sp. 1.
Lingulella sp. 2.

343b [U. S. National Museum]. Upper Cambrian: Limestone pebble on Sachuset Beach, near Newport, R. I.
Lingulella bella.

344 (references follow species). (For stratigraphic position and association, see p. 133.) Middle Cambrian: Sandy shales of Division E3b of Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

Obolus lens [Matthew, 1903, p. 81]=Obolus (Palæobolus) bretonensis lens.
Lingulella atava [Matthew, 1903, p. 81].
Lingulella [Matthew, 1903, p. 58].
Acrothele abavia [Matthew, 1903, p. 81]=Acrothele avia.
Acrothele avia [Matthew, 1903, p. 81].

344a (references follow species). (For stratigraphic position and association, see p. 133.) Middle Cambrian: Sandy shales of Division E3c of Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

Lingulella sp. [Matthew, 1903, p. 26].
Lingulella collicia [Matthew, 1903, p. 26].
Acrothele abavia [Matthew, 1903, p. 26]=Acrothele avia.
Acrotreta sp. [Matthew, 1903, p. 26].
*Acrothyra proavia [Matthew, 1902b, p. 422].
Bradoria scrutator [Matthew, 1903, p. 163].

344b (references follow species). (For stratigraphic position and association, see p. 133.) (See 13n″). Middle Cambrian: Sandy shales of Division E3d of Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

Lingulella atava [Matthew, 1903, p. 81].
*Obolus (Palæobolus) bretonensis [Matthew, 1903, p. 81].
Acrothele avia [Matthew, 1903, p. 81].
Acrothyra proavia [Matthew, 1903, p. 91].
*Bradorona spectator æquat [Matthew, 1903, p. 81].

344e (references follow species). (For stratigraphic position and association, see p. 133.) Middle Cambrian: Sandy shales of Division E3d of Matthew's Etcheminian on Gregwa Brook, Indian River, eastern Cape Breton, Nova Scotia.

Obolus (Palæobolus) bretonensis [Matthew, 1903, p. 142].
*Acrothele avia puteis [Matthew, 1903, p. 100].

344d [Matthew, 1903, p. 82]. (See 13n.) (For stratigraphic position and association, see p. 133.) Middle Cambrian: Sandy shales of Division E3f of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

Lingulella atava.
Leptobolus collicia=Lingulella collicia.
Leptobolus collicia collis=Lingulella collicia.
Acrothele proles.
Acrothyra proavia crassa=Acrothyra proavia.
Acrothyra proavia prima=Acrothyra proavia.
Hyolithes.
Leperditia? rugosa.
*Bradorona perspicator major.
Bradoria scrutator.
Escasona rutellum.
*Indiana lippa.
Eurypteroid crustacean.
Solenopleura bretonensis.
Schmidtella? acuta.

344e (references follow species). (For stratigraphic position and association, see p. 134.) Middle Cambrian: Shales of Division E1d of Matthew's [1903, pp. 28 and 29] Etcheminian on Boundary Brook, eastern side of the Escasonie Indian Reservation, eastern Cape Breton, Nova Scotia.

Lingulella cf. collicia [Matthew, 1903, p. 78].
Leptobolus atavus tritavus [Matthew, 1903, p. 78]=Lingulella torrentis.
Lingulella (Lingulepis) gregwa [Matthew, 1903, p. 78].
Lingulella (Lingulepis) sp. [Matthew, 1903, p. 78].
Obolus sp. [Matthew, 1903, p. 78].
Acrotreta papillata [Matthew, 1903, p. 78]=Acrothyra sera.
Acrotreta papillata lata [Matthew, 1903, p. 78]=Acrothyra sera.
Orthotheca sp. [Matthew, 1903, p. 78].
*Bradorona observator [Matthew, 1903, p. 78].
*Bradorona observator benepuncta [Matthew, 1903, p. 78].
Bradorona perspicator [Matthew, 1903, p. 78].
Bradorona spectator [Matthew, 1903, p. 78].
Bradorona spectator acuta [Matthew, 1903, p. 159].
Bradoria vigilans obesa [Matthew, 1903, pp. 78 and 152].
*Escasona rutellum prima [Matthew, 1903, p. 78; rutellum vetus on p. 152].
*Schmidtella (?) pervetus concinna [Matthew, 1903, p. 78].

344f [Matthew, 1903, p. 72]. (See 13k.) (For stratigraphic position and association, see p. 135.) Middle Cambrian: Shales of the Coldbrook terrane of Matthew, on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

Obolus torrentis.
*Lingulella torrentis.
Lingulella cf. longovalis=Lingulella cf. triparilis.
*Lingulella (Lingulepis?) pumila.
Acrotreta papillata prima=Acrothyra sera.
Acrothyra signata prima.
Hyolithes.
*Indiana ovalis prima.
*Escasona?? ingens.

344g (references follow species). (For stratigraphic position and association, see p. 134.) (See 13t″.) Middle Cambrian: Shales of Division E1c of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River Valley, Cape Breton, Nova Scotia.

Lingulella longovalis [Matthew, 1903, p. 77]=Lingulella triparilis.
Lingulella triparilis [Matthew, 1903, p. 77].
Lingulella cf. tumida [Matthew, 1903, p. 23].
Lingulella (Lingulepis) gregwa [Matthew, 1903, p. 77].
Acrotreta papillata [Matthew, 1903, p. 95]=Acrothyra sera.
*Acrothyra signata sera [Matthew, 1903, p. 77]=Acrothyra sera.
Acrothyra signata tarda [Matthew, 1903, p. 77]=Acrothyra sera.
Hyolithes [Matthew, 1903, p. 77].
Orthotheca [Matthew, 1903, p. 77].
*Bradorona perspicator maxima [Matthew, 1903, p. 77].
Bradorona spectator [Matthew, 1903, p. 77].
*Bradoria ornata [Matthew, 1903, p. 77].
Bradoria rugulosa var. [Matthew, 1903, p. 166].
Bradoria vigilans obesa [Matthew, 1903, p. 152].
Crustacean [Matthew, 1903, p. 77].

344h (references follow species). (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandy layers in the shales of Division E1e of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

Obolus discus [Matthew, 1903, p. 79]=Lingulella triparilis.
Lingulella longovalis [Matthew, 1903, p. 79]=Lingulella triparilis.
Lingulella cf. tumida [Matthew, 1903, p. 24].
Lingulella (Lingulepis) gregwa robusta [Matthew, 1903, p. 79].
Leptobolus sp. [Matthew, 1903, p. 79].
Obolus sp. [Matthew, 1903, p. 79].
Orthotheca sp. [Matthew, 1903, p. 79].
Hyolithes sp. [Matthew, 1903, p. 79].
*Bradorona spectator spinosa [Matthew, 1903, p. 79].
*Indiana ovalis [Matthew, 1903, p. 79].

344i (references follow species). (See 13 l′.) (For stratigraphic position and association, see p. 133.) Middle Cambrian: Sandy shales of Division E3a of Matthew's [1903, p. 21] Etcheminian on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

Acrothele abavia [Matthew, 1903, p. 80]=Acrothele avia.
Acrothyra proavia [Matthew, 1903, p. 80].
Obolus (Palæobolus) bretonensis [Matthew, 1903, p. 143].
Obolus lens [Matthew, 1903, p. 80]=Obolus (Palæobolus) bretonensis lens.

344j [Matthew, 1903, p. 91]. (For stratigraphic position and association, see p. 133.) Middle Cambrian: Division E3e of Matthew's [1903, p. 21] Etcheminian on the highway at V. McPhees, eastern Cape Breton, Nova Scotia.

Acrothyra proavia.

344k (references follow species). (See 13t′.) (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandstones of Division E1b of Matthew's [1903, p. 21] Etcheminian on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

Lingulella longovalis [Matthew, 1903, p. 77]=Lingulella triparilis.
Lingulella triparilis [Matthew, 1903, p. 77].
Lingulella (Lingulepis) gregwa? [Matthew, 1903, p. 77].
Leptobolus? [Matthew, 1903, p. 77].
*Acrothyra signata [Matthew, 1903, p. 77].
Bradorona observator lævis [Matthew, 1903, p. 77].
Bradorona spectator [Matthew, 1903, p. 159].
*Bradorona spectator acuta [Matthew, 1903, p. 77].
*Bradoria vigilans obesa [Matthew, 1903, p. 77].

344l (references follow species). (For stratigraphic position and association, see p. 134.) (See 13e.) Middle Cambrian: Sandstones of Division E2c of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

*Acrothyra signata orta [Matthew, 1903, p. 90].
Bradorona observator lævis [Matthew, 1903, p. 161].

344m (references follow species). (See 13t″.) (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandy shales of Division E1d of Matthew's [1903, p. 21] Etcheminian on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

*Lingulella (Lingulepis) gregwa [Matthew, 1903, p. 78].
*Lingulella (Lingulepis) gregwa robusta [Matthew, 1903, p. 78].
Acrotreta papillata [Matthew, 1903, p. 78]=Acrothyra sera.
Acrothyra signata tarda [Matthew, 1903, p. 78]=Acrothyra sera.
Orthotheca sp. [Matthew, 1903, p. 78].
Bradorona observator [Matthew, 1903, desc. of Pl. XII, fig. 15].
Bradorona observator benepuncta [Matthew, 1903, desc. of Pl. XII, fig. 16].
*Bradorona perspicator [Matthew, 1903, p. 157].
Bradorona spectator [Matthew, 1903, p. 78].
Bradorona spectator acuta [Matthew, 1903, p. 78].

344n [Matthew, 1903, p. 33]. (For stratigraphic position and association, see p. 134.) Middle Cambrian: Shales in the gorge at the old mill on McCodrum Brook, Mira River, eastern Cape Breton, Nova Scotia.

Lingulella (Lingulepis) gregwa.

344o [Matthew, 1903, p. 134]. (See 10p and 10q.) (For stratigraphic position and association, see p. 134.) Middle Cambrian: Sandstones of Division E2b of Matthew's [1903, p. 21] Etcheminian on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

*Lingulella (Lingulepis) longinervis.

345 (references follow species). (For stratigraphic position and association, see p. 124.) Middle Cambrian: Greenish shale in the *Paradoxides* zone on the Dlouhá Hora, above the brook of Sbirov, near Skrej, Bohemia, Austria-Hungary.

*Lingulella (?) sp. [Pompeckj, 1896b, p. 509]=Lingulella cf. ferrugiuea.
Acrothele bohemica [Pompeckj, 1896b, p. 509].
Billingsella romingeri [U. S. National Museum and Pompeckj, 1896b, p. 509].
*Orthis sp. [Pompeckj, 1896b, p. 514, fig. 6]=Eoorthis sp. undt. a.
Ptychoparia striata [Pompeckj, 1896b, p. 509].
Ellipsocephalus hoffi [Pompeckj, 1896b, p. 509].
Conocoryphe sulzeri [Pompeckj, 1896b, p. 511].
Agraulos spinosus [Pompeckj, 1896b, p. 511].
Agraulos ceticephalus [Pompeckj, 1896b, p. 511].

345a [Pompeckj, 1896b, p. 511]. (For stratigraphic position and association, see p. 124.) Middle Cambrian: Shales in the *Paradoxides* zone on the right bank of the brook of Karásek, near Tejřovik, Bohemia, Austria-Hungary.

Acrothele bohemica.

345b [Pompeckj, 1896b, p. 511]. (For stratigraphic position and association, see p. 124.) Middle Cambrian: In the "Bande de Jinec" at Felbabka and Jinec, Bohemia, Austria-Hungary.

Acrothele bohemica.

345c (references follow species). (For stratigraphic position and association, see p. 124.) Middle Cambrian: Shales of Étage C at Mleschitz, Bohemia, Austria-Hungary.
*Acrothele bohemica [Barrande, 1879b, Pl. CII].
Billingsella romingeri (U. S. National Museum).

345d [Pompeckj, 1896b, p. 511]. (For stratigraphic position and association, see p. 124.) Middle Cambrian: Shales of *Paradoxides* zone, Forester House of Slapy (Buchava quarry), Skrej, Bohemia, Austria-Hungary.
*Acrothele quadrilineata.

345e [Pompeckj, 1896b, p. 514]. (For stratigraphic position and association, see p. 124.) Middle Cambrian: Greenish shale in the *Paradoxides* zone in the gorge above Luh, near Skrej, Bohemia, Austria-Hungary.
*Eoorthis sp. undt. b.

345f (references follow species). (For stratigraphic position and association, see p. 124.) Middle Cambrian: Étage C near Skrej, Bohemia, Austria-Hungary.
Nisusia (Jamesella) kuthani (U. S. National Museum).
*Billingsella romingeri [Barrande, 1879a, Pl. LXII].

345g [Barrande, 1879a, Pl. LXII]. (For stratigraphic position and association, see p. 124.) Middle Cambrian: Étage C at Praschno Augezd, Bohemia, Austria-Hungary.
Billingsella romingeri.

345h [Barrande, 1879a, Pl. LXII]. (For stratigraphic position and association, see p. 124.) Middle Cambrian: Étage C at Slap, Bohemia, Austria-Hungary.
Billingsella romingeri.

345i [U. S. National Museum and Pompeckj, 1896b, p. 514]. (For stratigraphic position and association, see p. 124.) Lower Cambrian: Conglomeratic quartzitic sandstones and graywacke inclusions in the lower conglomerate zone of the Kamenná hůrka near Tejřovik, Bohemia, Austria-Hungary.

*Nisusia (Jamesella) kuthani.
*Nisusia (Jamesella) perpasta.
*Nisusia (Jamesella) perpasta macra.
*Nisusia (Jamesella) perpasta subquadrata.

345j [Pompeckj, 1896b, p. 514]. (For stratigraphic position and association, see p. 124.) Lower Cambrian: Conglomeratic quartzitic sandstones and graywacke inclusions in the lower comglomerate zone of the Kamenná hůrka at Gross Lohovic, southwest of Skrej, Bohemia, Austria-Hungary.

Nisusia (Jamesella) kuthani.
Nisusia (Jamesella) perpasta.
Nisusia (Jamesella) perpasta macra.
Nisusia (Jamesella) perpasta subquadrata.

345k [U. S. National Museum]. (For stratigraphic position and association, see p. 124.) Lower Cambrian: Sandstones at Slapnicky mlýn, near Skrej, Bohemia, Austria-Hungary.
Nisusia (Jamesella) kuthani.
Nisusia (Jamesella) perpasta.

345l [U. S. National Museum]. (For stratigraphic position and association, see p. 124.) Middle Cambrian: Shales of Étage C at Jinec, Bohemia, Austria-Hungary (Museum Regni Bohemiæ).
Billingsella romingeri.

346 [U. S. National Museum]. Lower Cambrian: Limestone and shale a little south of Emigsville, York County, Pa.
Acrothele decipiens.

346a [U. S. National Museum]. Lower Cambrian: Limestone in Landis Valley, Pa. (H. J. Roddy).
Micromitra (Paterina) bella.

346b [U. S. National Museum]. Upper Cambrian: Conococheague limestone,[a] 2.75 miles (4.4 km.) south of Mercersburg, Franklin County, Pa.
Eoorthis desmopleura.

346c [U. S. National Museum]. Lower Cambrian: Shale near York, York County, Pa. (A. Wanner).
Nisusia festinata.

347 [von Toll, 1899, p. 27]. Lower Cambrian: Near Tschurskaja Station, on Lena River, Siberia.
Kutorgina cingulata.

350 [de Verneuil and Barrande, 1860, p. 538]. Middle Cambrian: Red limestone of the *Paradoxides* zone near Adrados, north of Sabero and Boñar, Cantabrian Mountains, Province of Leon, northwestern Spain.

*Acrothele primæva.
*Eoorthis primordialis.
*Nisusia? vaticina.
*Nisusia (Jamesella) pellico.
*Brachiopode nouv. gen.=Botsfordia barrandei.
Paradoxides pradoanus.
Arionellus ceticephalus.
Conocephalites sulzeri.
Conocephalites sulzeri var.
Conocephalites coronatus.
Conocephalites ribeiro.
Agnostus 2 sp.
Leperditia.
Capulus cantabricus.
Capulus sp.
Trochocystites bohemicus?.

[a] Stose, Mercersburg-Chambersburg folio (No. 170), Geol. Atlas U. S., U. S. Geol. Survey, 1909, p. 6.

350a [Barrois, 1882, p. 186]. Ordovician: Sandstones of the stage of Cabo Busto in the cliffs of Cape Vidio, Province of Oviedo, northeastern Spain.
*Lingulella heberti.

350b [Barrois, 1882, p. 186]. Ordovician: Sandstones of the stage of Cabo Busto at Los Negros, northeastern Spain.
Lingulella heberti.

351 (references follow species). Lower Cambrian: Shales at Monte de Valbom, northeast of Villa Boim, Province of Alemtejo, Portugal.

Obolella maculata [Delgado, 1904, p. 364]=Acrothele villaboimensis.
*Obolella cf. atlantica [Delgado, 1904, p. 364]=Obolella sp.
*Acrothele villaboimensis [Delgado, 1904, p. 365].
*Delgadella lusitanica [Delgado, 1904, p. 365].
Lingulepis acuminata meeki [Delgado, 1904, p. 366]=Lingulella delgadoi.
*Lingulella granvillensis [Delgado, 1904, p. 367]=Lingulella delgadoi.
*Lingulella ferruginea [Delgado, 1904, p. 368]=Lingulella delgadoi.
*Lingulella cf. linguloides [Delgado, 1904, p. 369]=Lingulella delgadoi.
*Paradoxides choffati [Delgado, 1904, p. 319].
Paradoxides sp. aff. abenacus [Delgado, 1904, p. 322].
Paradoxides sp. n. aff. spinosus [Delgado, 1904, p. 323].
Paradoxides costæ [Delgado, 1904, p. 323].
Paradoxides sp. aff. tessini [Delgado, 1904, p. 324].
Olenopsis sp.
Olenellus? (hypostoma).
Hicksia elvensis [Delgado, 1904, p. 333].
Hicksia sphærica [Delgado, 1904, p. 335].
Hicksia transtaganensis [Delgado, 1904, p. 337].
Hicksia walcotti [Delgado, 1904, p. 338].
Hicksia castroi [Delgado, 1904, p. 340].
Hicksia hughesi [Delgado, 1904, p. 341].
Hicksia barroisi [Delgado, 1904, p. 342].
Hicksia delwalquei [Delgado, 1904, p. 343].
Hicksia minuta [Delgado, 1904, p. 344].
Metadoxides hornemanni [Delgado, 1904, p. 345].
Olenellus (?) macphersoni [Delgado, 1904, p. 347].
Microdiscus caudatus [Delgado, 1904, p. 349].
Microdiscus subcaudatus [Delgado, 1904, p. 350].
Microdiscus wenceslasi [Delgado, 1904, p. 350].
Microdiscus souzai [Delgado, 1904, p. 351].
Microdiscus woodwardi [Delgado, 1904, p. 353].
Crustacean (?) (telson).
Crustacean sp.
Hyolithes lusitanicus [Delgado, 1904, p. 355].
Hyolithes cf. billingsi [Delgado, 1904, p. 356].
Hyolithes sp. aff. communis [Delgado, 1904, p. 356].
Pteropoda sp.
Posidonomya malladai [Delgado, 1904, p. 357].
Fordilla troyensis [Delgado, 1904, p. 358].
Modiolopsis zitteli [Delgado, 1904, p. 359].
Modiolopsis bocagei [Delgado, 1904, p. 360].
Synek (?) cambrensis [Delgado, 1904, p. 360].
Davidia dollfusi [Delgado, 1904, p. 361].
Davidia cotteri [Delgado, 1904, p. 362].
Davidia egozcuei [Delgado, 1904, p. 362].
Ctenodonta geikiei [Delgado, 1904, p. 363].
Bivalve sp.

These species may not be from the same bed or even from the same locality.

353 [Roemer, 1849, p. 420]. Upper Cambrian: Limestones on Sau Saba River, San Saba County, Tex.
*Lingulella acutangula. No other associated species (Roemer).

353a [Shumard, 1860, p. 627]. Upper Cambrian: Sandstones near the head of Morgans Creek, Burnet County, Tex.
*Billingsella coloradoensis.

353b [U. S. National Museum]. Upper Cambrian: Sandstone just beneath the *Ophileta* beds, south end of the Franklin Range, El Paso County, Tex.
Lingulella (Lingulepis) acuminata.

353c [U. S. National Museum]. Upper Cambrian: Heavy dark ferruginous sandstone in Llano County, Tex. (exact locality uuknown).
Lingulella acutangula.

354 (references follow species). Middle? Cambrian: In yellowish-brown slates not far from the buildings of Canal Grande, island of Sardinia, Italy.

*Lingula attenuata [Bornemann, 1891, p. 438]=Lingulella bornemanni.
*Kutorgina cingulata [Bornemann, 1891, p. 440]=Kutorgina sardiniaensis.
Olenopsis [Bornemann, 1891, p. 440].
Metadoxides [Bornemann, 1891, p. 440].
Lingulella sp. undt. (U. S. National Museum).

These species may not be from the same bed or even from the same exact locality.

354a (references follow species). Middle? Cambrian: In grayish-white quartzitic sandstone in the valley of Gutturu Sartu, island of Sardinia, Italy.

*Lingula hawkei [Bornemann, 1891, p. 439]=Mickwitzia sp. undt.
Lingula attenuata [Bornemann, 1891, p. 438]=Lingulella bornemanni.
Olenopsis bornemanni [Bornemann, 1891, p. 458].
Olenopsis zoppi [Bornemann, 1891, p. 459].
Metadoxides armatus [Bornemann, 1891, p. 465].
Metadoxides bornemanni [Bornemann, 1891, p. 466].
Metadoxides torosus [Bornemann, 1891, p. 462].
Etc.

These species may not be from the same bed or even from the same exact locality.

354b (references follow species). (See 354c.) Middle? Cambrian: In yellowish sandstone with *Archæocyathus* at Punta Pintau and elsewhere, island of Sardinia, Italy.

Lingula attenuata [Bornemann, 1891, p. 438]=Lingulella bornemanni.
Kutorgina cingulata [Bornemann, 1891, p. 440]=Kutorgina sardiniaensis.
Carinaropsis patelloides [Bornemann, 1891, p. 441].
Capulus minutus [Bornemann, 1891, p. 441].
Olenopsis bornemanni [Bornemann, 1891, p. 458].
Etc.

These species may not be from the same bed or even from the same exact locality.

354c (references follow species). (See 354b.) Middle? Cambrian: Yellow friable sandstone at Punta Pintau (Canal Grande), island of Sardinia, Italy.

*Lingula petalon [Bornemann, 1891, p. 438]=Obolus? meneghinii.
Metadoxides arenarius [Bornemann, 1891, p. 467].
Paradoxides asper [Bornemann, 1891, p. 468].
Etc.

These species may not be from the same bed or even from the same exact locality.

354d [Bornemann, 1891, p. 438]. Middle? Cambrian: Yellow friable sandstone at Gruguetta, island of Sardinia, Italy.

Lingula petalon=Obolus? meneghinii.

354e (references follow species). Middle? Cambrian: Shale at Porto Canal Grande, island of Sardinia, Italy.

Obolella sp. [Bornemann, 1891, p. 440]=Obolus? meneghinii.
Lingula roualti [Bornemann, 1891, p. 439]=Kutorgina sardiniaensis.
Kutorgina sardiniaensis (U. S. National Museum).
Bellerophon? priscus [Bornemann, 1891, p. 441].
Olenopsis bornemanni [Bornemann, 1891, p. 458].
Olenopsis longispinatus [Bornemann, 1891, p. 459].
Olenopsis zoppi [Bornemann, 1891, p. 459].
Metadoxides armatus [Bornemann, 1891, p. 465].
Etc.

These species may not be from the same bed or even from the same exact locality.

354f [Bornemann, 1891, p. 439; U. S. National Museum]. Middle? Cambrian: Reddish-yellow sandstone near the houses of Canal Grande, on the road to Punta Pintau, island of Sardinia, Italy.

*Obolella crassa=Obolus? zoppi.

355 [U. S. National Museum]. Middle Cambrian: Sandstones on Red Canyon Creek, southwest side of Black Hills, South Dakota. Some of the specimens are labeled Redwater Canyon, and this locality appears in Whitfield [1882, p. 340].

*Lingulella cuneola.
*Lingulella perattenuata.
Lingulella (Lingulepis) acuminata.
Dicellomus nanus.
Dicellomus politus.

355a [U. S. National Museum]. Middle Cambrian: Shales in Bear Gulch Valley, Black Hills, South Dakota.

Lingulella similis.

355b [U. S. National Museum]. Middle Cambrian: Sandstone in the Deadwood formation on Castle Creek, on the west side of the Black Hills, South Dakota.

Lingulella (Lingulepis) acuminata.
Dicellomus pectenoides.

355c [Whitfield, 1875, p. 103]. Middle Cambrian: Sandstone on French Creek, Black Hills, South Dakota.

*Dicellomus pectenoides.

355d [U. S. National Museum]. Middle Cambrian: Sandstone in the Black Hills, South Dakota.

Lingulella (Lingulepis) acuminata.
*Dicellomus nanus.

355e [U. S. National Museum]. Middle Cambrian: Sandstone in the central part of the Black Hills, South Dakota.

Dicellomus politus.

355f.[a] Middle Cambrian: Sandstones near Deadwood, Black Hills, South Dakota.

Lingulella perattenuata.

357 [Waagen, 1885, p. 769]. Middle Cambrian: Limestone in the "*Neobolus* beds" of the Khussak group, above the salt mine at Kiura (Khewra), Salt Range, India.

*Lingulella kiurensis.

357a (references follow species). Middle Cambrian: Lower portion of the "*Neobolus* beds" of the Khussak group, in purplish-colored, fine-grained, micaceous sandstone, at Jutána, Salt Range, India.

*Neobolus warthi [Waagen, 1885, p. 759]
Neobolus wynnei [Waagen, 1885, p. 760]
Davidsonella linguloides [Waagen, 1885, p. 765]
Davidsonella squama [Waagen, 1885, p. 767]
} =Neobolus warthi.
*Discinolepis granulata [Waagen, 1885, p. 751].

[a] The authority for the citation of this locality was mislaid and could not be traced in time for insertion in this volume.

357b [Waagen, 1885, p. 759]. Middle Cambrian: Lower portion of the "*Neobolus* beds" of the Khussak group, in purplish-colored, fine-grained, micaceous sandstone, at Chél Hill, Salt Range, India.
Neobolus warthi.

357c (references follow species). Middle Cambrian: Lower portion of the "*Neobolus* beds" of the Khussak group, in purplish-colored, fine-grained, micaceous sandstone, near the fresh-water springs in a gorge above the salt mines at Kiura (Khewra), Salt Range, India.
*Schizopholis rugosa [Waagen, 1885, p. 754].
Neobolus warthi [Waagen, 1885, p. 759].....
Neobolus wynnei [Waagen, 1885, p. 760].....} =Neobolus warthi.
Davidsonella linguloides [Waagen, 1885, p. 765]..
Discinolepis granulata [Waagen, 1885, p. 751].

357d [Waagen, 1891, p. 104]. Middle Cambrian: "Concretionary shales of the Khussak group" at several localities between Chél Hill and Kiura (Khewra), eastern part of the Salt Range, India.

*Wynnia warthi.	Conocephalites warthi.
Hyolithes wynnei.	Trilobites gen. and sp. undt.

358 [U. S. National Museum]. Middle Cambrian: Argillaceous shale 50 feet (15.2 m.) above the Coronado quartzite [Lindgren, 1905, p. 3], west side of Chase Creek Canyon, 1.5 miles (2.4 km.) east-northeast of Morenci, Clifton quadrangle (U. S. G. S.), Graham County, Ariz.
Lingulella lineolata.

358a [U. S. National Museum]. Upper? Cambrian: Siliceous limestone on Ash Creek, in Pinal County, Ariz.
Lingulella pogonipensis?.
Dicellomus politus.

358b [U. S. National Museum]. Middle Cambrian: Limestone on the southwest side of Escabrosa Ridge, 4.5 miles (7.2 km.) west-southwest of Bisbee, Ariz. (F. L. Ransome, 1902).
Obolus zetus.

360 [U. S. National Museum]. Lower Ordovician: Red siliceous limestone near Colorado Springs, El Paso County, Colo.
Lingulella desiderata.
Schizambon manitouensis.
Eoorthis desmopleura.

360a [U. S. National Museum]. Lower Ordovician: Red siliceous limestone on west side of Trout Creek, below Bergen Park, 7 miles (11.2 km.) north-northwest of Manitou, El Paso County, Colo.

Obolus matinalis.	Eoorthis desmopleura.
Lingulella desiderata.	Eoorthis wichitaensis.

360b [U. S. National Museum]. Lower Ordovician: Red siliceous limestone on Cement Creek, 3 miles (4.8 km.) north of Hot Springs, Ouray County, Colo.
Lingulella desiderata.

360c [U. S. National Museum]. Lower Ordovician: Red siliceous limestone about 10 miles (16.1 km.) southeast of Crested Butte, Elk Range, Colo.
Lingulella desiderata.

360d [U. S. National Museum]. Middle Cambrian: Siliceous limestones near Pike View, north of Colorado Springs, El Paso County, Colo.
Lingulella similis.

360f [U. S. National Museum]. Lower Ordovician: Siliceous limestone at Glen Eyre, Queens Canyon, northeast of Manitou, El Paso County, Colo.
*Eoorthis desmopleura.

360g [U. S. National Museum records]. Upper Cambrian: Shaly sandstone on Trout Creek, 1 mile (1.6 km.) below Manitou Park, El Paso County, Colo.
Lingulella (Lingulepis) acuminata.

360h [U. S. National Museum]. (100 feet above 360i; see locality 3g.) Upper Cambrian: Sandy shales about 200 feet (61 m.) above the base of the section at Glenwood Springs, Garfield County, Colo. (T. W. Stanton, 1889).
Obolus mæra.

360i [U. S. National Museum]. (100 feet below 360h; see locality 3g.) Upper Cambrian: Sandstones about 100 feet (30 m.) above the base of the section at Glenwood Springs, Garfield County, Colo. (T. W. Stanton, 1889).
Obolus mæra.

361 [U. S. National Museum]. (For stratigraphic position and association, see p. 147.) Upper Cambrian: Shaly limestone in suburb of Attalla, Etowah County, Ala. (M. R. Campbell).
Lingulella desiderata.
Acrotreta kutorgai.

362 [U. S. National Museum]. (For stratigraphic position and association, see p. 147.) Upper Cambrian: Shales in the Oothkalooga Valley, Bartow County, Ga.
Lingulella desiderata.

362a [U. S. National Museum]. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Sandy shale a short distance west of Cave Spring, Floyd County, Ga.
Lingulella similis.

364 [Sardeson, 1896, p. 95]. Upper Cambrian: St. Lawrence formation in both Wisconsin and Minnesota.
Lingulella mosia.

364a [Sardeson, 1896, p. 95]. Lower Ordovician: "Oneota dolomite" along St. Croix River in both Wisconsin and Minnesota.
Lingulella mosia.

366 [Davidson, 1866, p. 57]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Whitesand Bay, near St. Davids Head, Pembrokeshire, South Wales.
Lingulella davisi.

366a [U. S. National Museum]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Upper portion of Middle *Lingula* flags 6 miles (9.6 km.) east of Ffestiniog, Merionethshire, North Wales.
Lingulella davisi.

366b [U. S. National Museum]. (For stratigraphic position and association, see p. 136.) Middle Cambrian: Red shales at the base of the Harlech grits at Porthclais Harbor, south of St. Davids, South Wales.
Lingulella ferruginea.

366c [Salter and Etheridge, 1881, p. 538]. (See 318i.) (For stratigraphic position and association, see p. 136.) Middle? Cambrian: "Caerfai group" at Caerfai, Nuns Hill, and Porthclais Harbor, south of St. Davids, South Wales.
*Lingulella primæva.

366d [Davidson, 1866, p. 57]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower *Lingula* flags at Carnedd Filiast, Bangor, Carnarvonshire, North Wales.
Lingulella davisi.

366e [Davidson, 1866, p. 57]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower *Lingula* flags at Marchillyn-mawr, Llanberis, Carnarvonshire, North Wales.
Lingulella davisi.

366f [Davidson, 1866, p. 57]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower *Lingula* flags at Ffestiniog, Merionethshire, North Wales.
Lingulella davisi.

366g [Davidson, 1866, p. 57]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower *Lingula* flags at Dolgelly, Merionethshire, North Wales.
Lingulella davisi.

366h [Davidson, 1866, p. 57]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower *Lingula* flags at Pen-y-Bryn, 5 miles (8 km.) north of Dolgelly, Merionethshire, North Wales.
Lingulella davisi.

366i [Davidson, 1866, p. 57]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower *Lingula* flags at Llyn Dywarchen, Merionethshire, North Wales.
Lingulella davisi.

366j [Davidson, 1866, p. 57.] (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower *Lingula* flags at Pont Nant-y-Lladron, on the Bala Road from Ffestiniog, Merionethshire, North Wales.
Lingulella davisi.

366k [Davidson, 1866, p. 57]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower *Lingula* flags at Penmorfa, Merionethshire, North Wales.
Lingulella davisi.

366l [Davidson, 1866, p. 57). (For stratigraphic position and association, see p. 135). Upper Cambrian: Lower *Lingula* flags at Tremadoc, Merionethshire, North Wales.
Lingulella davisi.

366m [Davidson, 1866, p. 57]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower *Lingula* flags near Nant-y-groes, west of Bala, Merionethshire, North Wales.
Lingulella davisi.

366n [U. S. National Museum]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Lower *Lingula* flags at Portmadoc, Merionethshire, North Wales.
Lingulella davisi.

366o [McCoy, 1854, p. 254]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: "Bala schists" at Bryn Melyn, near Bala, Merionethshire, North Wales.
Lingulella davisi.

366p [Davidson, 1866, p. 57]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Upper Tremadoc beds at Deudraeth, Merionethshire, North Wales.
Lingulella davisi.

366q (references follow species). (For stratigraphic position and association, see p. 135.) Upper Cambrian: Upper Tremadoc beds at Garth, opposite Portmadoc, Merionethshire, North Wales.
Lingulella davisi [Davidson, 1866, p. 57].
Lingulella lepis [Davidson, 1866, p. 54].

366r [U. S. National Museum]. (For stratigraphic position and association, see p. 135.) Upper Cambrian: Shales 2 miles (3.2 km.) north of Builth, Brecknockshire, South Wales.
Lingulella davisi.

366s [U. S. National Museum]. (See 366a.) (For stratigraphic position and association, see p. 135.) Upper Cambrian: Upper *Lingula* flags 5 miles (8 km.) east of Ffestiniog, Merionethshire, North Wales.
Orusia lenticularis.

367 [U. S. National Museum]. Lower Cambrian: Conglomerate and limestone, Troy, Rensselaer County, N. Y.
*Lingulella schucherti.
Microdiscus schucherti.
Protypus hitchcocki (Whitfield).
These species may be from widely different localities.

367a [U. S. National Museum]. (See 38.) Lower Cambrian: Limestone about a third of a mile (0.5 km.) south of John Hulett's farmhouse, 3 miles (4.8 km.) west of South Granville, and 4.5 miles (7.2 km.) southwest of Granville, Fort Ann quadrangle (U. S. G. S.), Washington County, N. Y.
Billingsella salemensis.

367b [U. S. National Museum]. Lower Cambrian: Sandstone at Lansingburg, north of Troy, Cohoes quadrangle (U. S. G. S.), Rensselaer County, N. Y.
Billingsella salemensis??.
Scenella sp.

367c [U. S. National Museum]. Ordovician: Beekmantown limestone, Division A, quarry near the northwest suburbs of Ticonderoga, Essex County, N. Y.
*Lingulella (Lingulepis) acuminata sequens.

367d (references follow species). Middle Cambrian: Limestones near Stissing, Dutchess County, N. Y.
*Micromitra (Paterina) stissingensis [Dwight, 1889, p. 145].
Hyolithes billingsi? [Dwight, 1889, p. 143].
*Leperditia ebenina [Dwight, 1889, p. 144].
*Olenoides stissingensis [Dwight, 1889, p. 147].

367e [Dwight, 1886, p. 205]. Upper Cambrian: Shaly limestones 850 feet (259.1 m.) southerly from the southwest corner of the driving park and 2,200 feet (670.6 m.) west of the road leading southerly from the same, about 1 mile (1.6 km.) southwest of Vassar College, near Poughkeepsie, Dutchess County, N. Y.
Lingulella (Lingulepis) acuminata.

367f [U. S. National Museum]. Upper Cambrian: Sandstone at French Creek, 1 mile (1.6 km.) east of Keeseville, Essex County, N. Y.
Lingulella prima.

367g [U. S. National Museum]. Upper Cambrian: Sandstone in the bed of the brook in the suburbs of Port Henry, Essex County, N. Y.
Lingulella prima.

367h [U. S. National Museum]. Upper Cambrian: Sandstone at Rosses Bridge, 4 miles (6.4 km.) west of Essex village, Essex County, N. Y.
Lingulella prima.

367i [Hall, 1847, p. 290]. Lower Cambrian: Shales near Troy, Rensselaer County, N. Y.
*Botsfordia cælata.

367j [U. S. National Museum]. (See 108.) Upper Cambrian: Sandstones 3 miles (4.8 km.) south of Poughkeepsie, Dutchess County, N. Y.
Lingulella (Lingulepis) acuminata.

367k [U. S. National Museum]. (See 109.) Upper Cambrian: Sandstone at Deweys Bridge, Washington County, N. Y.
Lingulella (Lingulepis) acuminata.

3671 [U. S. National Museum]. Cambrian: Shales 0.75 mile (1.2 km.) southwest of Hillsdale, Fort Ann quadrangle (U. S. G. S.), Washington County, N. Y. (L. M. Prindle, 1895).
Obolus sp.

368 (references follow species). Middle Cambrian: Quartzitic sandstone in the Pepper Mountains, near Sandomierz on the Vistula, Russian Poland.

Obolus apollinis (U. S. National Museum).
*Lingulella siemiradzkii (U. S. National Museum).
Lingula cf. crassa [Gurich, 1896, p. 214]=Lingulella siemiradzkii.
Paradoxides cf. tessini [Gurich, 1896, p. 17].
Paradoxides bohemicus [Gurich, 1896, p. 17].
Agnostus fallax [Gurich, 1896, p. 17].
Agnostus gibbus [Gurich, 1896, p. 17].
Liostracus linnarssoni [Gurich, 1896, p. 17].

368a [Siemiradzki, 1886, p. 672]. Gray sandstone of unknown stratigraphic position or age in the Polnischen Mittelgebirge, north of Sandomierz on the Vistula, Russian Poland.
Obolus (Mickwitzella) siluricus.

369 [U. S. National Museum]. (For stratigraphic position and association, see p. 137.) Upper Cambrian: Sandstone in the Elvins formation in the eastern limits of the town of Flat River, St. Francois County, Mo.

*Obolus ismene.
Lingulella texana.
Linnarssonella girtyi.
Eoorthis indianola.

369a [U. S. National Museum]. (For stratigraphic position and association, see p. 137.) Middle Cambrian: Limestone in or just beneath the "Edgewise beds" near Elvins, 6 miles (9.6 km.) south of Bonneterre, St. Francois County, Mo.
Eoorthis wichitaensis.

369b [U. S. National Museum]. Upper Cambrian: Limestone near Potosi, Washington County, Mo.
Eoorthis indianola.

369c [U. S. National Museum]. (For stratigraphic position and association, see p. 137.) Upper Cambrian: Dolomite above the "Edgewise beds" in a railroad cut 0.5 mile (0.8 km.) southwest of Elvins, 6 miles (9.6 km.) south of Bonneterre, St. Francois County, Mo. (E. O. Ulrich).
Billingsella major?.

369d [U. S. National Museum]. (For stratigraphic position and association, see p. 137.) Upper Cambrian: Upper portion of the Elvins formation 2.5 to 3 miles (4 to 4.8 km.) north of Caledonia, Washington County, Mo.
Billingsella coloradoensis.

369e [U. S. National Museum]. (For stratigraphic position and association, see p. 137.) Upper Cambrian: Sandstone on Big River, near Montana, Iron County, Mo.
Billingsella coloradoensis.

369f [Walcott, 1891b, p. 341]. (For stratigraphic position and association, see p. 137.) Middle Cambrian: Limestone at Fredericktown, Madison County, Mo.
Obolus lamborni.

369g [U. S. National Museum]. (For stratigraphic position and association, see p. 137.) Middle Cambrian: Shales at Bonneterre, St. Francois County, Mo.
Lingulella desiderata.

369h [U. S. National Museum]. (For stratigraphic position and association, see p. 137.) Middle Cambrian: Shale at Mine Lamotte, Madison County, Mo. (C. D. Walcott and F. B. Meek).
Obolus lamborni.

372 [U. S. National Museum]. (See 8d.) (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shale at Upper Leitches Creek, eastern Cape Breton, Nova Scotia.
Lingulella concinna.

372a [U. S. National Museum]. (See 10m.) (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shale 2 miles (3.2 km.) south of the Boisdale road from Upper Leitches Creek, eastern Cape Breton, Nova Scotia.
Lingulella concinna.

372b [U. S. National Museum]. (See 3p.) (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shale in ravine 0.5 mile (0.8 km.) north of McMullins, on the crossroad to Boisdale railroad station, eastern Cape Breton, Nova Scotia.
Lingulella concinna.

372c [U. S. National Museum]. (See 3o.) (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shale in ravine east of the railroad, just south of Barachois post office, eastern Cape Breton, Nova Scotia.
Lingulella concinna.

372d [U. S. National Museum]. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shale on McAdam shore, East Bay, east of Bras d'Or Lake, eastern Cape Breton, Nova Scotia.
Lingulella concinna.

372e [Matthew, 1903, p. 50]. (For stratigraphic position and association, see p. 131.) Upper Cambrian: Shales on McMullins Brook, near McLeod Brook (=Barachois River), eastern Cape Breton, Nova Scotia, Canada.
Monobolina refulgens.
Schizambon priscus.

372f [U. S. National Museum]. (For stratigraphic position and association, see p. 134.) Middle Cambrian: Shales on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.
Lingulella (Lingulepis) longinervis.

374 [U. S. National Museum]. (For stratigraphic position and association, see p. 147.) Middle Cambrian: In the suburbs of and 4 and 11 miles (6.4 and 17.7 km.) north-northeast of Knoxville, Knox County, Tenn.
Lingulella similis.

374a [U. S. National Museum]. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Limestone 2 miles (3.2 km.) south of Coal Creek, Anderson County, Tenn.
Dicellomus appalachia.

374b [U. S. National Museum]. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shale 1.25 miles (2 km.) from Rogersville, on the road to Powell, near the line between the Morristown and Greeneville quadrangles (U. S. G. S.), Hawkins County, Tenn.
Dicellomus appalachia.

374c [U. S. National Museum]. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Sandy shale (Nolichucky?) [Campbell, 1899, p. 3] 8 miles (12.8 km.) northeast of Shipleys, near the line between the Roan Mountain and Bristol quadrangles (U. S. G. S.), Sullivan County, Tenn.
Dicellomus appalachia.

374d [U. S. National Museum]. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shale 2 miles (3.2 km.) north of Rotherwood, Hawkins County, Tenn. (Cooper Curtice).
Lingulella (Lingulepis) acuminata.

374e [U. S. National Museum]. (For stratigraphic position and association, see p. 147.) Middle Cambrian: Shales collected near the state line, 2.25 miles (3.6 km.) north of Peltier, Estillville quadrangle (U. S. G. S.), Sullivan County, Tenn. (M. R. Campbell).
Obolus willisi.

386 [Gagel, 1890, p. 34]. Passage beds between the Upper Cambrian and the Ordovician: Drift blocks of *Ceratopyge* limestone near Belschwitz, East Prussia, Germany.
Eoorthis daunus.

386a [Gagel, 1890, p. 34]. Passage beds between the Upper Cambrian and the Ordovician: Drift blocks of "Glauconite limestone" near Prussian Holland, 90 miles (145 km.) south-southwest of Konigsberg, East Prussia, Germany.
Orthis christianiæ=Eoorthis daunus?.

386b (references follow species). Passage beds between the Upper Cambrian and Ordovician: Drift blocks of "Glauconite limestone" near Wehlau, 30 miles (48.3 km.) east of Konigsberg, East Prussia, Germany.
Obolus (Acritis) antiquissimus [Gagel, 1890, p. 22].
Orthis christianiæ [Gagel, 1890, p. 34]=Eoorthis daunus?.
} These species may occur in different blocks of limestone.

386c [Roemer, 1885, p. 23 (270)]. Upper Cambrian: Drift bowlder found near Lyck, East Prussia, Germany.
Obolus apollinis.

386d [Roemer, 1885, p. 23 (270)]. Upper Cambrian: Drift bowlder found near Danzig, West Prussia, Germany.
Obolus apollinis.

386e [Roemer, 1885, p. 33 (280)]. Upper Cambrian: Drift bowlders of gray bituminous limestone between Vistula and Elbe rivers. in Schleswig-Holstein and Mecklenburg-Schwerin, Germany.
Orusia lenticularis.
Parabolina spinulosa.

386f [Roemer, 1885, p. 34 (281)]. Upper Cambrian: Drift bowlders of gray bituminous limestone near Wismar, Mecklenburg-Schwerin, Germany.

Orusia lenticularis.

386g [Roemer, 1885, p. 34 (281)]. Upper Cambrian: Drift bowlders of gray bituminous limestone near Rostock, Mecklenburg-Schwerin, Germany.

Orusia lenticularis.

386h [Roemer, 1885, p. 34 (281)]. Upper Cambrian: Drift bowlders of gray bituminous limestone near Meseritz, Province of Posen, Germany.

Orusia lenticularis.

386i (references follow species). (For stratigraphic position and association, see p. 143.) Ordovician: Drift bowlder of *Echinosphærites* limestone near Wehlau, 30 miles (48.3 km.) east of Konigsberg, East Prussia, Germany.

Siphonotreta unguiculata [Gagel, 1890, p. 23].

Siphonotreta verrucosa [Gagel, 1890, p. 22].

386j [Gagel, 1890, p. 23]. (For stratigraphic position and association, see p. 143.) Ordovician: Drift bowlder of *Echinosphærites* limestone at Belschwitz, East Prussia, Germany.

Siphonotreta unguiculata.

386k [Gagel, 1890, p. 22]. (For stratigraphic position and association, see p. 143.) Ordovician: Drift bowlder of *Echinosphærites* limestone near Wormditt, East Prussia, Germany.

Siphonotreta unguiculata.

Siphonotreta verrucosa.

386l [Gagel, 1890, p. 22]. (For stratigraphic position and association, see p. 143.) Ordovician: Drift bowlder of *Echinosphærites* limestone near Marienwerder, West Prussia, Germany.

Siphonotreta unguiculata.

Siphonotreta verrucosa.

389 [Kayser, 1876, p. 8]. Upper Cambrian: Sandstone at Salta, Province of Salta, Argentina, South America.

*Eoorthis saltensis.

389a [Kayser, 1876, p. 8]. Upper Cambrian: Sandstone at Nevado de Castillo, Province of Salta, Argentina, South America.

Eoorthis saltensis.

389b (references follow species). Upper Cambrian: Sandstone at Tilcuya, Province of Jujuy, Argentina, South America.

Orusia lenticularis [Kayser, 1876, p. 9].
Eoorthis saltensis [Kayser, 1876, p. 8].
*Obolus sp. undt. e [Kayser, 1876, p. 9].
Hyolithes sp. undt. [Kayser, 1876, p. 8].
Agnostus tilcuyensis [Kayser, 1876, p. 5].
Olenus argentinus [Kayser, 1876, p. 6].
Arionellus lorenzi [Kayser, 1876, p. 7].
Arionellus hyeronimi [Kayser, 1876, p. 7].

389c [Kayser, 1897, p. 280]. Upper Cambrian: Conglomeratic sandstone at Ojo de Agua, Province of Santiago del Est, about 70 miles (112 km.) north of Cordova, Argentina, South America.

*Eoorthis saltensis.

389d (references follow species). Upper Cambrian: At Iruya, Province of Salta, Argentina, South America.

Lingulella davisi [Kayser, 1897, p. 280].
Lingulella ferruginea [Kayser, 1897, p. 280].
Eoorthis saltensis [Kayser, 1897, p. 280].
Agnostus iruyensis [Kayser, 1897, p. 279].
Liostracus ulrichi [Kayser, 1897, p. 277].
Liostracus steinmanni [Kayser, 1897, p. 277].

390 [U. S. National Museum]. (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: Boundary stratum between the *Orthoceras* limestone and *Ceratopyge* limestone [Moberg and Segerberg, 1906, p. 69] at Alunbruk (alum works), southern part of Oeland Island, Sweden.

*Eoorthis tullbergi.

390a [Moberg, 1892b, p. 112]. (For stratigraphic position and association, see p. 146.) Lower Cambrian: Drift blocks of glauconitic quartzitic sandstone at several points near Stora Rör, Kalmar sheet (Geol. Survey Sweden), Oeland Island, Sweden.

*Micromitra (Paterina) undosa.

Discinella.

390b (references follow species). (For stratigraphic position and association, see p. 145.) Upper Cambrian: Limestone of the *Shumardia* zone (zone 3) at Fogelsång, 5 miles (8 km.) east of Lund, Province of Malmöhus, Sweden.

Eoorthis wimani [Moberg and Segerberg, 1906, p. 71].
Trochus atavus [Moberg and Segerberg, 1906, desc. of Pl. III].
Shumardia œlandica [Moberg and Segerberg, 1906, desc. of Pl. IV].
Shumardia dicksoni [Moberg and Segerberg, 1906, desc. of Pl. IV].
Symphysurus angustatus [Moberg and Segerberg, 1906, desc. of Pl. V].
Orometopus elatifrons? [Moberg and Segerberg, 1906, desc. of Pl. VII].

390c (references follow species). (For stratigraphic position and association, see p. 145.) Upper Cambrian: *Ceratopyge* slate (zone 3) at Wentlinge, Oeland Island, Sweden.

Eoorthis wimani [Moberg and Segerberg, 1906, p. 70].
Beyrichia nanella [Moberg and Segerberg, 1906, desc. of Pl. III].
Shumardia œlandica [Moberg and Segerberg, 1906, desc. of Pl. IV].
Cyrtometopus primigenus [Moberg and Segerberg, 1906, desc. of Pl. VII].

390d [Moberg, 1892b, p. 112]. (For stratigraphic position and association, see p. 146.) Lower Cambrian: Drift blocks of glauconitic quartzitic sandstone north of Röhälla, Kalmar sheet (Geol. Survey Sweden), Oeland Island, Sweden.

Micromitra (Paterina) undosa.
Discinella.

390e [Moberg and Segerberg, 1906, pp. 71 and 109]. (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: *Apatocephalus* zone of the *Ceratopyge* suite at Ottenby, Oeland Island, Sweden.

Eostrophomena elegantula.

390f (U. S. National Museum). (For stratigraphic position and association, see p. 144.) Passage beds between the Upper Cambrian and the Ordovician: Shales between the "lower graptolite slate" and the *Ceratopyge* limestone at Mossebo, on Hunneberg, western boundary of the Province of Skaraborg, Sweden.

*Protorthis? hunnebergensis.

390g [Moberg and Segerberg, 1906, p. 64, and U. S. National Museum]. (See 309i.) (For stratigraphic position and association, see p. 145.) Upper Cambrian: Limestone in the *Dictyograptus* slate at Sandby, 6 miles (9.6 km.) east-northeast of Lund, Province of Malmöhus, Sweden.

Obolus (Bröggeria) salteri.

390h [Moberg, 1892b, p. 112]. (For stratigraphic position and association, see p. 146.) Lower Cambrian: Drift blocks of glauconitic quartzitic sandstone on Nordmannaskär Island, Kalmar sheet (Geol. Survey Sweden), Sweden.

Micromitra (Paterina) undosa.
Discinella.

390i (U. S. National Museum). (See 310d.) (For stratigraphic position and association, see p. 145.) Upper Cambrian: Limestone band in the *Ceratopyge* slate at Borgholm, Oeland Island, Sweden.

Obolus (Bröggeria) salteri.

390j (references follow species). (For stratigraphic position and association, see p. 146.) Lower Cambrian: *Eophyton* sandstone at Lugnås, 8 miles (12 km.) south-southwest of Mariestad, Province of Skaraborg, Sweden.

*Hyolithes lævigatus [Linnarsson, 1871, p. 9].
*Mickwitzia monilifera [U. S. National Museum and Linnarsson, 1869a, p. 344].
*Mickwitzia pretiosa (U. S. National Museum).
Arenicolites spiralis [Linnarsson, 1869b, p. 398].
Fræna tenella [Linnarsson, 1871, p. 11].
*Agelacrinus? lindströmi [Linnarsson, 1871, p. 1].
Cruziana dispar [Linnarsson, 1869a, p. 353].
Eophyton linnæanum [Linnarsson, 1869b, p. 399].
*Eophyton torelli [Linnarsson, 1869a, p. 351].
*Dictyonema sp. [Linnarsson, 1871, p. 13].
*Astylospongia radiata [Linnarsson, 1871, p. 13].
*Bythotrephis sp. [Linnarsson, 1871, p. 18].
Scotolithus mirabilis [Linnarsson, 1871, p. 18].

390k.[a] (For stratigraphic position and association, see p. 146.) Lower Cambrian: *Eophyton* sandstone at Prestorp, north of the hill of Billingen, southeast of Lake Vennern, Province of Skaraborg, Sweden.

Mickwitzia monilifera.

3901 [Moberg and Segerberg, 1906, p. 65]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: *Obolus* conglomerate at Klittberget, in Dalarne, Province of Kopparberg, Sweden.

Obolus apollinis.

390m [Moberg and Segerberg, 1906, p. 65]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Conglomerate overlying a glauconite sand at Horn, northern part of Oeland Island, Sweden.

Obolus apollinis.

390n [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Limestones of *Olenus* zone at Hunneberg, western boundary of the Province of Skaraborg, Sweden.

Orusia lenticularis.
Parabolina spinulosa.

390o [U. S. National Museum]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: Arenaceous shales at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad, Sweden.

Orusia lenticularis. (Von Buch [1834, p. 48] cites this species from "aluminiferous schists" at Andrarum, and the two localities may be the same.)

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[a] The authority for the citation of this locality was mislaid and could not be traced in time for insertion in this volume.

390p [Davidson, 1869, p. 231]. (For stratigraphic position and association, see p. 145.) Upper Cambrian: At Kinnekulle, northeast of Lidköping, Province of Skaraborg, Sweden.
Orusia lenticularis.

392 [U. S. National Museum]. Upper Cambrian: Potsdam sandstone at Burgess, Canada.
Lingulella (Lingulepis) acuminata.

392a [U. S. National Museum; see Walcott, 1891b, p. 254]. Lower Cambrian: Limestones at L'Anse au Loup, on the north shore of the Straits of Belleisle, Labrador.

Micromitra (Paterina) bella.
*Micromitra (Paterina) labradorica.
*Obolella chromatica.
*Kutorgina cingulata.
Nisusia festinata.
*Nisusia (Jamesella) sp. undt.
Orthis 2 sp.
Palæophycus incipiens.
Archæocyathus profundus (Billings).
Spirocyathus atlanticus (Billings).
Coscinocyathus billingsi Walcott.
Stenotheca elongata Walcott.
Stenotheca rugosa (Hall).
Hyolithes billingsi Walcott.
Salterella pulchella Billings.
Salterella rugosa Billings.
Mesonacis vermontana (Hall).
Olenellus logani Walcott (Geol. Survey Canada).
Ptychoparia miser Billings.
Protypus senectus Billings.
Solenopleura (like S. nana Ford).

392b [Matthew, 1895b, p. 258]. Upper Cambrian: Sandstone at Beverly, township of Bastard, county of Leeds, Ontario, Canada. This sandstone corresponds to the passage beds above the massive Potsdam sandstone at Chateaugay Falls, New York.
Lingulella (Lingulepis) acuminata.

392c [Billings, 1872a, p. 218]. Lower Cambrian: At the Straits of Belleisle, Labrador.

*Bicia gemma.
Obolella chromatica.
Obolella crassa.
Obolella desquamata=Obolella crassa.
Botsfordia cælata.
Quebecia circe.

392d [Billings, 1856, p. 34]. Upper Cambrian: Sandstone on Lot 11, 11th concession, township of Lansdowne, county of Leeds, Ontario, Canada.
Lingulella (Lingulepis) acuminata.

392e [Billings, 1856, p. 34]. Upper Cambrian: Sandstone on Lot 22, 9th concession, township of Bastard, county of Leeds, Ontario, Canada.
Lingulella (Lingulepis) acuminata.

392g [Dawson, 1888a, p. 55]. Middle? Cambrian (probably between the Middle and Upper Cambrian): Black shales at Little Metis, Province of Quebec, Canada.
Obolella ida=Acrotreta sagittalis.

392h [Billings, 1859, p. 432]. Ordovician: Limestone of the "Chazy formation" in the valley of Ottawa River, above Carillon, Quebec, Canada.
Obolus belli.

392i [Billings, 1865a, p. 220]. Lower Ordovician: Limestone at Phillipsburgh, Province of Quebec, Canada.
Syntrophia calcifera.
Bathyurus saffordi.

392j [U. S. National Museum]. Lower Ordovician: Limestones of the "Quebec group" at Point Levis, Province of Quebec, Canada.
*Syntrophia calcifera.

392l [Geological Survey of Canada]. Lower Cambrian: Arenaceous limestone at Point Amour, Straits of Belleisle, Labrador.

Kutorgina cingulata.
Obolella chromatica.
Stenotheca cf. elongata Walcott.
Discinella.
Archæocyathus.
Olenellus sp.?.

392m [U. S. National Museum]. (See 392i.) Upper Cambrian: Sandstone on the east shore of Missisquoi Bay, 1.5 miles (2.4 km.) south of Phillipsburgh, Province of Quebec, Canada (C. D. Walcott, 1888).
Lingulella (Lingulepis) acuminata.

392n [U. S. National Museum]. Upper Cambrian: Sandstone in easteru Canada, exact locality unknown (Geol. Survey Canada, 1876).
Lingulella (Lingulepis) acuminata.

392o [U. S. National Museum]. Lower Cambrian: Arenaceous limestone collected somewhere in Vermont, exact locality unknown (T. C. Wooster).

Rustella edsoni.

392p [U. S. National Museum]. Lower Cambrian: Shale on the Jewell farm, Franklin County, Vt.

Nisusia festiuata.

395 (references follow species). (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone at Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval, Government of Esthonia, Russia.

Obolus apollinis [Mickwitz, 1896, p. 137].
Obolus apollinis ingricus [Mickwitz, 1896, p. 139].
*Obolus apollinis maximus [Mickwitz, 1896, p. 144, and U. S. National Museum].
*Obolus apollinis quenstedti [Mickwitz, 1896, p. 145].
*Obolus eichwaldi [Mickwitz, 1896, p. 155].
*Obolus elegans [Mickwitz, 1896, p. 158].
*Obolus panderi [Mickwitz, 1896, p. 151].
*Obolus schmidti [Mickwitz, 1896, p. 153].
*Obolus volborthi [Mickwitz, 1896, p. 157].
*Obolus (Schmidtia) acuminatus [Mickwitz, 1896, p. 183, and U. S. National Museum].
*Obolus (Schmidtia) acuminatus alatus [Mickwitz, 1896, p. 184].
*Obolus (Schmidtia) acuminatus humeratus [Mickwitz, 1896, p. 186].
Obolus (Schmidtia) acuminatus subtriangularis [Mickwitz, 1896, p. 187].
Obolus (Schmidtia) celatus (U. S. National Museum).
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].
*Obolus (Schmidtia) crassus [Mickwitz, 1896, p. 192, and U. S. National Museum].
Obolus (Schmidtia) crassus angulatus [Mickwitz, 1896, p. 194].
*Obolus (Schmidtia) obtusus [Mickwitz, 1896, p. 171, and U. S. National Museum].
Obolus (Schmidtia) obtusus acutus [Mickwitz, 1896, p. 173].
Obolus (Schmidtia) obtusus ellipticus [Mickwitz, 1896, p. 178].
Obolus (Schmidtia) obtusus extenuatus [Mickwitz, 1896, p. 177].
Obolus (Schmidtia) obtusus latus [Mickwitz, 1896, p. 175].
Obolus (Schmidtia) obtusus longus [Mickwitz, 1896, p. 172].
Obolus (Schmidtia) obtusus minutus [Mickwitz, 1896, p. 176].
Lingulella (Leptembolon) lingulæformis (U. S. National Museum).
Keyserlingia buchi (U. S. National Museum).

395a (references follow species). (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone at Tihala, near Jegelecht, about 12 miles (19.3 km.) east of Reval, Government of Esthonia, Russia.

Obolus apollinis ingricus [Mickwitz, 1896, p. 139].
Obolus apollinis quenstedti [Mickwitz, 1896, p. 144].
Obolus (Schmidtia) acuminatus [Mickwitz, 1896, p. 183].
Obolus (Schmidtia) acuminatus alatus [Mickwitz, 1896, p. 184].
Obolus (Schmidtia) acuminatus humeratus [Mickwitz, 1896, p. 186].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].
Obolus (Schmidtia) crassus [Mickwitz, 1896, p. 192].

395b (references follow species). (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone at Ilgast, Government of Esthonia, Russia.

Obolus apollinis (U. S. National Museum).
Obolus elegans (U. S. National Museum).
Obolus (Schmidtia) acuminatus [Mickwitz, 1896, p. 183].
Obolus (Schmidtia) acuminatus alatus [Mickwitz, 1896, p. 184].
Obolus (Schmidtia) acuminatus humeratus [Mickwitz, 1896, p. 186].
Obolus (Schmidtia) acuminatus subtriangularis [Mickwitz, 1896, p. 187].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].
Obolus (Schmidtia) crassus [Mickwitz, 1896, p. 192].
Obolus (Schmidtia) crassus angulatus [Mickwitz, 1896, p. 194].
Obolus (Schmidtia) obtusus [Mickwitz, 1896, p. 171].
Obolus (Schmidtia) obtusus ellipticus [Mickwitz, 1896, p. 178].
Keyserlingia buchi (U. S. National Museum).

395c (references follow species). (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone at Asserien, 75 miles (121 km.) east of Reval, Government of Esthonia, Russia.

Obolus (Schmidtia) acuminatus [Mickwitz, 1896, p. 183].
Obolus (Schmidtia) acuminatus alatus [Mickwitz, 1896, p. 184].
*Obolus (Schmidtia) celatus [Volborth, 1869, p. 212].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].
Obolus (Schmidtia) crassus [Mickwitz, 1896, p. 192].

395d (references follow species). (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone at Ontika, about 95 miles (153 km.) east of Reval and 30 miles (48 km.) west of Narwa, Government of Esthonia, Russia.

Obolus (Schmidtia) acuminatus [Mickwitz, 1896, p. 183].
Obolus (Schmidtia) acuminatus alatus [Mickwitz, 1896, p. 184].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].
Obolus (Schmidtia) crassus [Mickwitz, 1896, p. 192].

395e (references follow species). (For stratigraphic position and association, see p. 144.) Upper Cambrian: *Obolus* sandstone at Isenhof, 85 miles (137 km.) east of Reval, Government of Esthonia, Russia.

Obolus (Schmidtia) acuminatus [Mickwitz, 1896, p. 183].
Obolus (Schmidtia) acuminatus alatus [Mickwitz, 1896, p. 184].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].
Obolus (Schmidtia) crassus [Mickwitz, 1896, p. 192].

395f [Mickwitz, 1896, p. 142]. (For stratigraphic position and association, see p. 144.) Upper Cambrian: *Obolus* conglomerate throughout the East Baltic region, Government of Esthonia, Russia.

Obolus apollinis.
Obolus apollinis maximus.

395g (references follow species). (For stratigraphic position and association, see p. 144.) Upper Cambrian: *Obolus* conglomerate at Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval, Government of Esthonia, Russia.

*Obolus triangularis [Mickwitz, 1896, p. 147].
Obolus triangularis inornatus [Mickwitz, 1896, p. 149].
Obolus (Schmidtia) celatus [Mickwitz, 1896, p. 163].
Obolus (Schmidtia) celatus orbiculatus [Mickwitz, 1896, p. 165].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].

395h (references follow species). Upper Cambrian: *Obolus* conglomerate at Tihala, near Jegelecht, about 12 miles (19.3 km.) east of Reval, Government of Esthonia, Russia.

Obolus (Schmidtia) celatus [Mickwitz, 1896, p. 163].
Obolus (Schmidtia) celatus orbiculatus [Mickwitz, 1896, p. 165].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].

395i (references follow species). (For stratigraphic position and association, see p. 144.) Upper Cambrian: *Obolus* conglomerate at Ilgast, Government of Esthonia, Russia.

Obolus triangularis [Mickwitz, 1896, p. 147].
Obolus (Schmidtia) celatus [Mickwitz, 1896, p. 163].
Obolus (Schmidtia) celatus orbiculatus [Mickwitz, 1896, p. 165].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].

395j (references follow species). (For stratigraphic position and association, see p. 144.) Upper Cambrian: *Obolus* conglomerate at Asserien, 75 miles (121 km.) east of Reval, Government of Esthonia, Russia.

Obolus (Schmidtia) celatus orbiculatus [Mickwitz, 1896, p. 165].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].

395k (references follow species). (For stratigraphic position and association, see p. 144.) Upper Cambrian: *Obolus* conglomerate at Ontika, about 95 miles (153 km.) east of Reval and 30 miles (48 km.) west of Narwa, Government of Esthonia, Russia.

Obolus (Schmidtia) celatus orbiculatus [Mickwitz, 1896, p. 165].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].

395l (references follow species). (For stratigraphic position and association, see p. 144.) Upper Cambrian: *Obolus* conglomerate at Isenhof, 85 miles (137 km.) east of Reval, Government of Esthonia, Russia.

Obolus (Schmidtia) celatus orbiculatus [Mickwitz, 1896, p. 165].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].

395m (references follow species). (For stratigraphic position and association, see p. 144.) Upper Cambrian: Sandstone below the *Obolus* conglomerate at Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval, Government of Esthonia, Russia.

Obolus (Schmidtia) celatus orbiculatus [Mickwitz, 1896, p. 165].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].

395n (references follow species). (For stratigraphic position and association, see p. 144.) Upper Cambrian: Sandstone below the *Obolus* conglomerate at Tihala, near Jegelecht, about 12 miles (19.3 km.) east of Reval, Government of Esthonia, Russia.

Obolus (Schmidtia) celatus orbiculatus [Mickwitz, 1896, p. 165].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].

395o (references follow species). (For stratigraphic position and association, see p. 144.) Upper Cambrian: Sandstone below the *Obolus* conglomerate at Ilgast, Government of Esthonia, Russia.

Obolus (Schmidtia) celatus [Mickwitz, 1896, p. 163].
Obolus (Schmidtia) celatus orbiculatus [Mickwitz, 1896, p. 165].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].

395p (references follow species). (For stratigraphic position and association, see p. 144.) Upper Cambrian: Sandstone below the *Obolus* conglomerate at Asserien, 75 miles (121 km.) east of Reval, Government of Esthonia, Russia.

Obolus (Schmidtia) celatus orbiculatus [Mickwitz, 1896, p. 165].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].

395q (references follow species). (For stratigraphic position and association, see p. 144.) Upper Cambrian: Sandstone below the *Obolus* conglomerate at Ontika, about 95 miles (153 km.) east of Reval and 30 miles (48 km.) west of Narwa, Government of Esthonia, Russia.

Obolus (Schmidtia) celatus orbiculatus [Mickwitz, 1896, p. 165].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].

395r (references follow species). (For stratigraphic position and association, see p. 144.) Upper Cambrian: Sandstone below the *Obolus* conglomerate at Isenhof, 85 miles (137 km.) east of Reval, Government of Esthonia, Russia.

Obolus (Schmidtia) celatus orbiculatus [Mickwitz, 1896, p. 165].
Obolus (Schmidtia) celatus præcisus [Mickwitz, 1896, p. 166].

395s [Mickwitz, 1896, p. 163]. (For stratigraphic position and association, see p. 144.) Upper Cambrian: *Schmidtia* conglomerate (part of the *Obolus* conglomerate) at Asserien, 75 miles (121 km.) east of Reval, Government of Esthonia, Russia.

Obolus (Schmidtia) celatus.

395t [Mickwitz, 1896, p. 163]. (For stratigraphic position and association, see p. 144.) Upper Cambrian: *Schmidtia* conglomerate (part of the *Obolus* conglomerate) at Ontika, about 95 miles (153 km.) east of Reval and 30 miles (48 km.) west of Narwa, Government of Esthonia, Russia.

Obolus (Schmidtia) celatus.

395u [Mickwitz, 1896, p. 163]. (For stratigraphic position and association, see p. 144.) Upper Cambrian: *Schmidtia* conglomerate (part of the *Obolus* conglomerate) at Isenhof, 85 miles (137 km.) east of Reval, Government of Esthonia, Russia.

Obolus (Schmidtia) celatus.

395v [Eichwald, 1843, p. 147]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: Sandstone on Odensholm Island, about 55 miles (88.6 km.) west of Reval, Government of Esthonia, Russia.

Obolus (Mickwitzella) siluricus.

395w [Eichwald, 1843, p. 147]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: In the chlorite-bearing sands in the limestone beds at Pawlowsk, near St. Petersburg, Russia.

Obolus (Acritis) antiquissimus.
Obolus (Mickwitzella) siluricus.

395x [Lamansky, 1901, p. 617]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: Glauconitic sandstone (correlated by Lamansky, 1901, p. 617, with the Upper Cambrian *Ceratopyge* slate) in the vicinity of Baltischport, about 30 miles (48 km.) west of Reval, Government of Esthonia, Russia.

Obolus (Mickwitzella) siluricus.

395y [Kutorga, 1848, p. 281]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: Sandstone on Pulkowa Brook, near St. Petersburg, Russia.

Obolus (Mickwitzella) siluricus.

395z (references follow species). (For stratigraphic position and association, see p. 143.) Upper Cambrian: *Obolus* sandstone at Jamburg on Louga (Luga) River, Government of St. Petersburg, Russia.

*Obolus apollinis [Eichwald, 1829, p. 274, and U. S. National Museum].
*Obolus apollinis ingricus [Eichwald, 1829, p. 274].
Obolus apollinis quenstedti [Mickwitz, 1896, p. 144].

396 (references follow species). (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: "Glauconite sandstone" at Baltischport, 30 miles (48 km.) west of Reval, Government of Esthonia, Russia.

Obolus (Mickwitzella) siluricus [Mickwitz, 1896, p. 198, and U. S. National Museum].
Lingulella (Leptembolon) lingulæformis [Mickwitz, 1896, p. 203].

396a (references follow species). (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: "Glauconite sandstone" at Leppiko, near Leetz, on the eastern side of the Baltischport peninsula, about 25 miles (40.3 km.) west of Reval, Government of Esthonia, Russia.

*Obolus (Mickwitzella) siluricus [Mickwitz, 1896, p. 198, and U. S. National Museum].
*Lingulella (Leptembolon) lingulæformis [Mickwitz, 1896, p. 203, and U. S. National Museum].
*Lingulella (Leptembolon) lingulæformis solidus [Mickwitz, 1896, p. 205].

396b (references follow species). (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: "Glauconite sandstone" at Fall, 15 miles (24 km.) west of Reval, Government of Esthonia, Russia.

Obolus (Mickwitzella) siluricus [Mickwitz, 1896, p. 198].
Lingulella (Leptembolon) lingulæformis [Mickwitz, 1896, p. 203].

396c (references follow species). (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: "Glauconite sandstone" at the mouth of Fähna Brook, east of Fall, about 15 miles (24 km.) west of Reval, Government of Esthonia, Russia.

Obolus (Mickwitzella) siluricus [Mickwitz, 1896, p. 198].
Lingulella (Leptembolon) lingulæformis [Mickwitz, 1896, p. 203].

396d (references follow species). (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: "Glauconite sandstone" at Domglint in Reval, Government of Esthonia, Russia.

Obolus (Acritis) antiquissimus (U. S. National Museum).
Obolus (Acritis) antiquissimus ventrosus [?].
Lingulella (Leptembolon) lingulæformis [Mickwitz, 1896, p. 203].

396e [Mickwitz, 1896, p. 198]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: "Glauconite sandstone" in the eastern part of the east Baltic region, Government of Esthonia, Russia.

Obolus (Mickwitzella) siluricus.

396f [Mickwitz, 1896, p. 204]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: "Glauconite sandstone" in the western part of the east Baltic region, Russia.

Lingulella (Leptembolon) lingulæformis.

396g [Eichwald, 1843, p. 143]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: In the upper limestone at Reval, Government of Esthonia, Russia.

*Obolus (Acritis) antiquissimus.

396h [Mickwitz, 1896, p. 213]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: "Glauconite limestone" at Tischer, 10 miles (16 km.) west of Reval, Government of Esthonia, Russia.

Obolus (Acritis) antiquissimus.

396i [Mickwitz, 1896, p. 213]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: "Glauconite limestone" at Fall, 15 miles (24 km.) west of Reval, Government of Esthonia, Russia.

Obolus (Acritis) antiquissimus.

396j [Mickwitz, 1896, p. 213]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: "Glauconite limestone" at Nömmeweske, near Palms, Government of Esthonia, Russia.

Obolus (Acritis) antiquissimus.

396k [Mickwitz, 1896, p. 213]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: "Glauconite limestone" at Iswes on the Wolchow, Government of St. Petersburg, Russia.

Obolus (Acritis) antiquissimus.

3961 [Mickwitz, 1896, p. 213]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: "Glauconite limestone" at Pulkowa, near St. Petersburg, Russia.

Obolus (Acritis) antiquissimus.

396m [Mickwitz, 1896, p. 213]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: "Lower lenticular layer" of the "glauconite limestone" at Saggad, east of Palms, Government of Esthonia, Russia.

Obolus (Acritis) antiquissimus.

396n [Mickwitz, 1896, p. 213]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: White limestone between the "glauconite limestone" and the sandy representative of the "*Vaginatum* limestone" at Leppiko, near Leetz, on the eastern side of the Baltischport peninsula, about 25 miles (40.3 km.) west of Reval, Government of Esthonia, Russia.

Obolus (Acritis) antiquissimus.

396o [Mickwitz, 1896, p. 213]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: "Glauconite limestone" in the entire western part of the east Baltic region, Government of Esthonia, Russia.

Obolus (Acritis) antiquissimus.

396p [Mickwitz, 1896, p. 213]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: Strata between the "lower lenticular layer" and the "*Vaginatum* limestone" proper at Nömmeweske, near Palms, Government of Esthonia, Russia.

Obolus (Acritis) antiquissimus.

396q [Schmidt, 1888, p. 24]. (For stratigraphic position and association, see p. 144.) Lower Cambrian: Upper boundary of the blue clay with the Fucoid sandstone (the "*Mickwitzia* conglomerate" [Schmidt, 1888, p. 24]), at Reval, Government of Esthonia, Russia.

Mickwitzia monilifera.

396r [Schmidt, 1888, p. 24]. (For stratigraphic position and association, see p. 144.) Lower Cambrian: In the "upper strata" at Streitberg, near Reval, Government of Esthonia, Russia.

Mickwitzia monilifera.

396s [Schmidt, 1888, p. 24]. (For stratigraphic position and association, see p. 144.) Lower Cambrian: In loose blocks on Kosch Brook near Likkat, near Reval, Government of Esthonia, Russia.

Mickwitzia monilifera.

396t [Schmidt, 1888, p. 24]. (For stratigraphic position and association, see p. 144.) Lower Cambrian: At the sandstone capes of Ziegelskoppel, Kakkomaggi (also Rocca al Mare), near Reval, Government of Esthonia, Russia.

Mickwitzia monilifera.

396u [Schmidt, 1888, p. 24]. (For stratigraphic position and association, see p. 144.) Lower Cambrian: In loose blocks on the lower course of Jaggowal Brook, about 20 miles (32.2 km.) east-southeast of Reval, Government of Esthonia, Russia.

Mickwitzia monilifera.
Traces of Olenellus.

396v [Schmidt, 1888, p. 24, and U. S. National Museum]. (For stratigraphic position and association, see p. 144.) Lower Cambrian: At the upper boundary of a dolomitic sandstone with which the *Olenellus* stratum begins, below the cement factory on Kunda Brook, Government of Esthonia, Russia.

Mickwitzia monilifera.
Traces of Olenellus.

396w [Schmidt, 1888, p. 24]. (For stratigraphic position and association, see p. 144.) Lower Cambrian: In the glauconitic sands above the main mass of the clay, below the cement factory on Kunda Brook, Government of Esthonia, Russia.

Mickwitzia monilifera.

396x [Eichwald, 1843, p. 146]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: In the chlorite-bearing sands in the limestone beds at Baltischport, about 30 miles (48 km.) west of Reval, Government of Esthonia, Russia.

Obolus (Acritis) antiquissimus.
Obolus (Mickwitzella) siluricus.

396y [Eichwald, 1843, p. 147]. (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: In the chlorite-bearing sands in the limestone beds at Reval, Government of Esthonia, Russia.

Obolus (Acritis) antiquissimus.
Obolus (Mickwitzella) siluricus.

396z [Kutorga, 1848, p. 283]. (See 336g.) (For stratigraphic position and association, see p. 143.) Passage beds between the Upper Cambrian and the Ordovician: Limestone in the vicinity of Zarskoe Selo, Government of St. Petersburg, Russia.

Obolus (Acritis) antiquissimus.

Localities C1–C75, Carnegie Institution of Washington Expedition to China.[a]

C1 (just above C4, same section; just below C2, same section; about 75 feet below C62, which occurs at a locality 3 miles east; about same horizon as C10, different section; about 150 feet below C12, same section). Middle Cambrian: Lower shale member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 40 (part of the third list of fossils), and fig. 10 (bed 4), p. 38], 2 miles (3.2 km.) south of Yenchuang, Sintai district, Shantung, China (Eliot Blackwelder, 11–27–1903).

*Obolus minimus.
Obolus (Westonia) blackwelderi.
Acrotreta pacifica.
Acrotreta shantungensis?.
Protospongia chloris Walcott.
Platyceras chronus Walcott.
Hyolithes cybele Walcott.
Agnostus chinensis Dames.
Dorypyge richthofeni Dames.
Inouyia divi (Walcott).
Anomocarella albion Walcott.
Anomocarella chinensis Walcott.
Lisania agonius (Walcott).
Dolichometopus alceste Walcott?.
Dolichometopus decerto Walcott.
Dolichometopus deois Walcott.

[a] See the explanatory paragraphs on pp. 160–161.

C2 (above C4, same section; just above C1, same section; about same horizon as C10, different section). Middle Cambrian: Lower shale member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 40 (part of the third list of fossils), and fig. 10 (beds 4 and 5), p. 38], 2 miles (3.2 km.) south of Yenchuang, Sintai district, Shantung, China (Eliot Blackwelder, 11–30–1903).

Obolus (Westonia) blackwelderi.
Acrotreta pacifica.
Protospongia chloris Walcott.
Hyolithes cybele Walcott.
Orthotheca cyrene dryas Walcott.
Agnostus chinensis Dames.
Dorypyge bispinosa Walcott.
Anomocare latelimbatum Dames.
Anomocarella albion Walcott.
Anomocarella biston (Walcott).
Anomocarella chinensis Walcott.
Coosia? daunus (Walcott).
Lisania agonius (Walcott).
Dolichometopus derceto Walcott.
Dolichometopus deois Walcott.
Lonchocephalus tellus (Walcott).

C3 (about 100 feet above the horizon of C60, different section; about 175 feet below the horizon of C8, different sections). Lower Cambrian: Lower part of the Manto shale formation [Blackwelder, 1907a, p. 28 (list of fossils at bottom of page), and fig. 8a (bed 20), p. 28], on the southeast slope of Hulushan, 2.5 miles (4 km.) southwest of Yenchuang, Sintai district, Shantung, China (Eliot Blackwelder, 11–30–1903).

*Billingsella richthofeni.
Stenotheca rugosa chinensis Walcott.
Hyolithes delia Walcott.
Redlichia nobilis Walcott.
Ptychoparia (Emmrichella) constricta (Walcott.)

C4 (just below C1, same section; same horizon as C57, different section). Middle Cambrian: In limestone nodules at the base of the lower shale member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 40 (second list of fossils), and fig. 10 (bed 4), p. 38], 3 miles (4.8 km.) southwest of Yenchuang, Sintai district, Shantung, China (Eliot Blackwelder, 11–27–1903).

*Acrothele matthewi eryx.
Acrotreta pacifica.
Protospongia chloris Walcott.
Platyceras chronus Walcott.
Hyolithes cybele Walcott.
Orthotheca delphus Walcott.
Agnostus chinensis Dames.
Anomocarella albion Walcott.
Anomocarella chinensis Walcott.
Lisania alala (Walcott).
Dolichometopus alceste Walcott.
Dolichometopus deois Walcott.

C5 (about 25 feet above C8, same section; about 40 feet below C63, same section). Middle Cambrian: Lower limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 39 (first list of fossils), and fig. 8a (bed 30), p. 29], 3.2 miles (5.1 km.) southwest of Yenchuang, Sintai district, Shantung, China (Eliot Blackwelder, 11–23–1903). On the figure this bed is placed as occurring below the line dividing the Manto from the Kiulung, but on the basis of the fauna contained in the limestone it is referred to the base of the Kiulung. The text (p. 39) places the boundary between the Kiulung and the Manto, 15 feet below C5.

Micromitra (Iphidella) pannula ophirensis.
*Acrotreta pacifica.
Globigerina? mantoensis Walcott.
Inouyia divi (Walcott).
Anomocare butes Walcott.
Anomocare sp.
Dolichometopus sp.

C6 (about 120 feet above C12, same section; about 20 feet below C61, same section). Middle Cambrian: Thin platy limestone in the upper shale member of the Kiulung group just below the Chaumitien limestone [Blackwelder, 1907a, pp. 37 and 41 (second list of fossils), and fig. 10 (bed 12), p. 38], 2.5 miles (4 km.) southwest of Yenchuang, Sintai district, Shantung, China (Eliot Blackwelder, 11–25–1903).

*Acrothele minuta.
*Obolus (Westonia) blackwelderi.
*Dicellomus parvus.
Agnostus douvillei Bergeron.
Blackwelderia sinensis (Bergeron).
Drepanura ketteleri Monke.
Drepanura premesnili Bergeron.
Ptychoparia (Emmrichella) bromus (Walcott).
Redlichia sp. undt. Walcott.
Shantungia spinifera Walcott.
Stephanocare? monkei Walcott.
Stephanocare richthofeni Monke.
Stephanocare sinensis (Bergeron).
Stephanocare? sp. undt. Walcott.
Liostracina krausei Monke.

C7 (just above C9, same section; about same horizon as C52, different sections; about 200 feet below C10, same section). Middle Cambrian: Lower limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 39 (last list of fossils), and fig. 8a (bed 33), p. 29], 2.2 miles (3.5 km.) southwest of Yenchuang, Sintai district, Shantung, China (Eliot Blackwelder, 11–23–1903).

Lingulella damesi.
Lingulella (Lingulepis) eros.
Inouyia abaris (Walcott).
Inouyia titiana (Walcott).
Agraulos dolon Walcott.
Anomocarella subrugosa (Walcott).
Anomocarella thraso (Walcott.)

C9 (just below C7, same section; about 25 feet above C63, same section; about same horizon as C52, different sections). Middle Cambrian: Lower limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 39 (third list of fossils), and fig. 8a (bed 33), p. 29], 3 miles (4.8 km.) southwest of Yenchuang, Sintai district, Shantung, China (?, 11–27–1903).

*Micromitra (Paterina) labradorica orientalis.
Inouyia abaris (Walcott).
Coosia decelus (Walcott).
Anomocare minus Dames.

C10 (about 200 feet above C7, same section; about same horizon as C1, C2, and C4, different section). Middle Cambrian: Lower shale member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 40 (part of the third list of fossils), and fig. 8a (bed 35), p. 29], about 3 miles (4.8 km.) southwest of Yenchuang, Sintai district, Shantung, China (Eliot Blackwelder, 11–23–1903).

*Lingulella damesi.
Anomocarella temenus (Walcott).
Menocephalus sp. undt. Walcott.

C12 (about 120 feet below C6, same section; about 75 feet above C62, same section but at a locality 3 miles east; C13 includes the horizon represented by C12; about 150 feet above C1, same section). Middle Cambrian: Gray limestone near the top of the middle limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 41 (part of first list of fossils), and fig. 10 (bed 7), p. 38], 3.25 miles (5.2 km.) southwest of Yenchuang, Sintai district, Shantung, China (Eliot Blackwelder and Li San, 11–25–1903).

Acrotreta pacifica.
Inouyia acalle (Walcott).
Lisania ajax (Walcott).
Damesella blackwelderi Walcott.
Blackwelderia alastor (Walcott).
Anomocarella tutia (Walcott).
Pterocephalus asiatica Walcott.
Teinistion alcon (Walcott).

C17 (about 180 feet below C23, same section; about 35 feet above C20, adjacent sections; about 160 feet below C28, adjacent sections). Lower Cambrian: Ferruginous limestone nodules in the brown sandy shales at the top of the Manto shale [Blackwelder, 1907a, p. 27 (list of fossils at top of page) and fig. 6 (bed 15), p. 25], at Changhia, Shantung, China (Eliot Blackwelder, 10–31–1903).

Obolella asiatica.
Ptychoparia aclis Walcott.
Ptychoparia impar Walcott.
Ptychoparia granosa Walcott.

C20 (about 15 feet above C31, same section; about 35 feet below C17, different sections). Lower Cambrian: Central part of the Manto shale formation [Blackwelder, 1907a, p. 26 (last list of fossils) and fig. 6 (bed 14), p. 25], on the west side of an isolated butte 1 mile (1.6 km.) south of Changhia, Shantung, China (Eliot Blackwelder, 10–27–1903).

Billingsella richthofeni?.
Ptychoparia aclis Walcott.
Ptychoparia (Emmrichella) mantoensis (Walcott).

C22 (about same horizon as C19, C24, and C26, same section; above C18, same section). Middle Cambrian: Changhia limestone in upper oolitic portion [Blackwelder, 1907a, pp. 22 and 33 (part of last list of fossils)], at Changhia, Shantung, China (Eliot Blackwelder, 10–29–1903).

*Acrotreta lisani.
Hyolithes cybele Walcott.
Anomocarella temenus (Walcott).
Lisania alala (Walcott).
Lisania bura (Walcott).
Menocephalus admeta Walcott.
Menocephalus acantha (Walcott).

C23 (about 180 feet above C17, same section; about 25 feet above C28, different sections). Middle Cambrian: Upper part of thin-bedded gray oolitic limestone at the base of the Changhia formation [Blackwelder, 1907a, p. 32 (second list of fossils) and fig. 6 (bed 20), p. 25], 50 feet below the base of the cliffs 1 mile (1.6 km.) east-southeast of Changhia, Shantung, China (Eliot Blackwelder, 10–27–1903).

Acrothele rara?.
Orthotheca daulis Walcott.
Agraulos abrota Walcott.
Anomocarella tatian (Walcott).
Ptychoparia (Emmrichella) eriopia (Walcott).
Ptychoparia (Emmrichella) theano (Walcott).

C24 (about same horizon as C19, C22, and C26, same section; above C18, same section; about same horizon as C25, different section). Middle Cambrian: Near top of black oolitic group in the uppermost layers of the Changhia formation [Blackwelder, 1907a, p. 33 (part of last list of fossils)], 2 miles (3.2 km.) east of Changhia, Shantung, China.

Acrotreta cf. pacifica.
Agnostus sp. undt.
Inouyia divi (Walcott).
Dolichometopus dirce Walcott.
Dorypyge richthofeni Dames.

C26 (about same horizon as C19, C22, and C24, same section; above C18, same section). Middle Cambrian: Upper portion of the Changhia limestone, near top of black oolitic group [Blackwelder, 1907a, p. 33 (part of last list of fossils)], 2 miles (3.2 km.) north-northeast of Changhia, Shantung, China (Eliot Blackwelder, 10–29–1903).

Eoorthis sp. undt.
Anomocare? daulis Walcott.
Crepicephalus damia Walcott.

C28 (about 200 feet above C20, same section; about 160 feet above C17, adjacent sections; about 25 feet below C23, different sections). Middle Cambrian: Thin-bedded oolitic limestone at the base of the Changhia limestone [Blackwelder, 1907a, p. 32 (first list of fossils) and fig. 6 (bed 20), p. 25], just above the shales in the face of the cliff 1 mile (1.6 km.) east-southeast of Changhia, Shantung, China (Eliot Blackwelder, 10–29–1903).

*Eoorthis agreste.
Anomocarella tenes (Walcott).
Anomocarella toxeus (Walcott).
Inouyia thisbe Walcott.
Bathyuriscus.

C32 (see also C32′, other drift blocks at the same locality). Middle Cambrian: A fine-grained bluish-black limestone bowlder believed to have come from the lower part of the Kisinling limestone [Blackwelder, 1907b, p. 272], collected in river drift 1 mile (1.6 km.) south of Chonpinghien, on Nankiang River, southern Shensi, China (Bailey Willis and Eliot Blackwelder, 5–28–1904).

Obolus shansiensis.
Dicellomus parvus.
Acrotreta shantungensis.
Orthotheca doris Walcott.
Microdiscus orientalis Walcott.
Aluta bergeroni (Walcott).
Aluta enyo (Walcott).
Aluta eris (Walcott).
Aluta fragilis (Walcott).
Aluta sterope (Walcott).
Aluta woodi (Walcott).

C32′ (see C32, another drift block at the same locality). Lower Cambrian: A limestone bowlder collected in river drift 1 mile (1.6 km.) south of Chonpinghien, on Nankiang River, southern Shensi, China (Bailey Willis and Eliot Blackwelder, 5–28–1904).

*Obolella asiatica.
Hyolithes sp. undt.

C36 (about same horizon as C45, different section; about same horizon as C50, same section; above C68, same section; about same horizon as C47, same section). Upper Cambrian: Upper part of the Chaumitien limestone [Blackwelder, 1907a, p. 36 (part of third list of fossils), and fig. 9 (bed 2), p. 35], at Chaumitien, Changhia district, Shantung, China (Eliot Blackwelder, 10–22–1903).

Billingsella pumpellyi.
Anomocarella baucis Walcott.

C37 (about same horizon as C72, same section; about 50 feet above C71, same section; about 200 feet below C73, same section; about 225 feet below C74, same section). Middle Cambrian: Upper part of the Kichou limestone, in dense black limestone nodules in green-gray shales 10 feet below the base of the cliff limestone, 8 miles (12.8 km.) south of Tinghianghien, Shansi, China (Eliot Blackwelder, 2–24–1904). The fossils from this locality are not listed, but the presence of Cambrian strata at the locality is mentioned by Willis and Blackwelder [1907, p. 146].

*Obolus shansiensis.
Acrotreta shantungensis.
Anomocare megalurus (Walcott).

C54 (same horizon as C41, C49, and C56; about same horizon as C34 and C38, different sections). Upper Cambrian: Lower part of Chaumitien limestone [Blackwelder, 1907a, p. 42 (part of last list of fossils)], near top of limestone knoll 0.66 mile (1.1 km.) west of Tsinan, Shantung, China (Eliot Blackwelder, 11–6–1903).

*Obolus matinalis?.
Eoorthis pagoda.
Syntrophia orthia.
Illænurus canens Walcott.
Illænurus sp. undt.
Pterocephalia busiris Walcott.
Ptychaspis ceto Walcott.
Ptychaspis sp. undt.

C56 (same horizon as C41, C49, and C54). Upper Cambrian: Lower part of Chaumitien limestone 25 feet below the top of Pagoda Hill [Blackwelder, 1907a, p. 42 (part of last list of fossils)], 1 mile (1.6 km.) west of Tsinan, Shantung, China (Eliot Blackwelder and Li San, 11–6–1903).

*Obolus (Westonia) sp. undt. a.
*Discinopsis? sulcatus.
Acrotreta (dorsal valve resembling that of A. pacifica).
*Eoorthis pagoda.
*Syntrophia orthia.
Scenella sp. undt. Walcott.
Platyceras pagoda Walcott.
Straparollina circe Walcott.
Orthotheca sp. undt. Walcott.
Cyrtoceras cambria Walcott.
Menocephalus depressus Walcott.
Pagodia bia Walcott.
Pagodia lotos Walcott.
Ptychaspis ceto Walcott.
Conocephalina dryope (Walcott).
Conocephalina belus (Walcott).
Illænurus dictys Walcott.
Hysterolenus?.

C57 (same horizon as C4, different section; below C11, same section; above C58, same section). Middle Cambrian: In limestone nodules in the lower shale member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 40 (first list of fossils)], 3 miles (4.8 km.) south of Kaokiapu and 4 miles (6.4 km.) north of Sintaihien, Sintai district, Shantung, China (?, 11–21–1903).

*Acrothele rara.
Orthotheca delphus Walcott.
Agnostus chinensis Dames.
Agnostus kushanensis Walcott.
Dorypyge richthofeni Dames.
Anomocare alcinoe Walcott.
Anomocarella albion Walcott.
Anomocarella chinensis Walcott.
Dolichometopus deois Walcott.

C61 (about 25 feet above C6, same section; about same horizon as C11, different section; about 125 feet below C64, same section). Upper Cambrian: A dense black limestone in the uppermost limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 41 (third list of fossils), and fig. 10 (bed 13), p. 38], 3 miles (4.8 km.) southwest of Yenchuang, Sintai district, Shantung, China (Li San, 11–23–1903).

*Billingsella pumpellyi.
Ptychaspis baubo (Walcott).
Proampyx burea Walcott.
Pterocephalia busiris Walcott.
Chuangia batia Walcott.
Chuangia fragmenta Walcott.

C62 (about 75 feet above C1, which occurs at a locality 3 miles east; about 75 feet below C12 and C13, same section). Middle Cambrian: Earthy layer in the middle limestone of the Kiulung group [Blackwelder, 1907a, pp. 37 and 40 (last list of fossils), and fig. 10 (base of bed 7), p. 38], 2.5 miles (4 km.) south of Yenchuang, on the north-northeast spur of Hulushan, Sintai district, Shantung, China (Li San, 11–29–1903).

*Obolus chinensis.
*Acrotreta shautungensis Walcott.
Hyolithes cybele Walcott.
Anomocarella chinensis Walcott.

C63 (about 40 feet above C5, same section; about 25 feet below C9, same section). Middle Cambrian: Sandy shale near the base of the Kiulung group [Blackwelder, 1907a, p. 37 (third paragraph), and fig. 8a (bed 32), p. 29], 3.5 miles (5.6 km.) southwest of Yenchuang, Sintai district, Shantung, China (Eliot Blackwelder, 11–27–1903).

*Obolus obscurus.

C64 (about 125 feet above C61, same section). Upper Cambrian: Upper limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 42 (first list of fossils), and fig. 10 (bed 20), p. 38], 2.7 miles (4.3 km.) southwest of Yenchuang, Sintai district, Shantung, China (Eliot Blackwelder, 11–25–1903).

Lingulella damesi?.
*Eoorthis doris.
*Eoorthis kayseri.
Eoorthis linnarssoni.
*Huenella orientalis.
Syntrophia orthia.
Hyolithes daphnis Walcott.
Orthotheca cyrene Walcott.
Anomocare sp.
Coosia bianos (Walcott).
Ptychaspis baubo (Walcott).
Ptychaspis cacus Walcott.
Ptychaspis callisto Walcott.
Ptychaspis calyce Walcott.
Ptychaspis ceto Walcott.
Ptychaspis sp.
Chuangia batia Walcott.
Chuangia nais Walcott.
Solenopleura beroe Walcott.

C67 (supposed to be from horizon of C36, C45, C47, C50, and C68). Upper Cambrian: Stream gravels taken from the wash from the mountains south of the city and used in making the railroad grade, 0.33 mile (0.5 km.) west of the west city gate at Tsinan, Shantung, China (Eliot Blackwelder, 10–15–1903).

Obolus cf. matinalis.
Eoorthis cf. linnarssoni.
Ptychaspis sp. undt. Walcott.

C68 (same horizon as C47 and C50, same section; below C36, same section; about same horizon as C45, different section). Upper Cambrian: Upper part of the Chaumitien limestone [Blackwelder, 1907a, p. 36 (part of third list of fossils)] on crest of ridge east of Chaumitien, 200 yards north of the wayside shrine, Changhia district, Shantung, China (Eliot Blackwelder, 10–25–1903).

Acrotreta (dorsal valve resembling that of A. pacifica).
Eoorthis kayseri.

C70 (35 feet below C69, same section). Middle Cambrian: Oolitic limestone about 30 feet above the base of the Kichou limestone [Willis and Blackwelder, 1907, p. 144, last list of fossils], 4 miles (6.4 km.) south-southwest of Tungyu, Shansi, China (Eliot Blackwelder, 2–21–1904).

Obolus sp. undt.	Inouyia capax (Walcott).
Scenella? dilatatus Walcott	Inouyia melie (Walcott).
Stenotheca? simplex Walcott.	Conocephalina maia (Walcott).
Agraulos vicina Walcott.	Conocephalina sp.

C71 (about 50 feet below the horizon of C37 and C72, same section; about 125 feet above C75, different section). Middle Cambrian: Massive cliff-making limestone in the central portion of the Kichou formation [Willis and Blackwelder, 1907, pp. 139 and 145 (second list of fossils)], 4 miles (6.4 km.) southwest of Tungyu, Shansi, China (Bailey Willis and Eliot Blackwelder, 2–21–1904).

Obolus shansiensis?.	Dorypyge richthofeni lævis Walcott.
Acrotreta shantungensis.	Anomocarella bigsbyi (Walcott).
*Yorkia? orientalis.	Anomocarella comus (Walcott).
Eoorthis sp. undt.	Anomocarella undata (Walcott).
Orthotheca glabra Walcott.	Solenopleura pauperata Walcott.
Agnostus chinensis Dames.	Crepicephalus damia Walcott.

C72 (about same horizon as C37, same section; about 50 feet above C71, same section; about 200 feet below C73, same section; about 225 feet below C74, same section). Middle Cambrian: Thin green-gray limestone interbedded with ocherous and green clay shales overlying the massive oolite in the Kichou formation [Willis and Blackwelder, 1907, pp. 139 and 145 (third list of fossils)], 4 miles (6.4 km.) east of Fanglanchon, Shansi, China (Eliot Blackwelder, 2–22–1904).

Obolus sp. undt.	Dorypyge richthofeni lævis Walcott.
*Lingulella (Lingulepis?) sp. undt.	Anomocare flava Walcott.
Platyceras willisi Walcott.	Ptychoparia nereis Walcott.
Orthotheca glabra Walcott.	Conocephalina sp. undt. (Walcott).

C74 (about 225 feet above the horizon of C37 and C72, same section; about 25 feet above C73, same section). Upper Cambrian: A dense blue dolomitic limestone at the top of the Kichou limestone [Willis and Blackwelder, 1907, pp. 139 and 145 (fifth list of fossils)], 4 miles (6.4 km.) east of Fanglanchon, Shansi, China (Eliot Blackwelder, 2–22–1904).

Eoorthis kayseri.
Ptychaspis bella Walcott.

C75 (about 125 feet below C71, different sections). Middle Cambrian: Limestone near the base of the Kichou formation [Willis and Blackwelder, 1907, p. 143], 4.5 miles (7.2 km.) south of Wutaihien, Shansi, China (Eliot Blackwelder, 2–13–1904).

Obolus obscurus.	Inouyia melie (Walcott).
*Eoorthis kichouensis.	Agraulos nitida Walcott.
Coscinocyathus elvira Walcott.	Agraulos uta Walcott.
Inouyia armatus (Walcott).	Ptychoparia lilia Walcott.

ZOOLOGICAL DISCUSSION.

The zoological relations of the Cambrian Brachiopoda, or their consideration from the paleozoologist's standpoint, are discussed under four general headings: (1) Characters of the shells, including the terminology adopted in describing them; (2) distribution in Cambrian strata; (3) evolution; and (4) classification. Under evolution no general description of the evolution of the Brachiopoda is attempted, nor is the life history of the living species treated. The discussion is limited to certain observations on the Cambrian species and genera that appear to add to our general knowledge of the subject.

TERMINOLOGY.

GENERAL STATEMENT.

Except for the muscle scars of the inarticulate brachiopods, the terms used in the description of genera and species are largely those defined by Schuchert [1897, pp. 73–75]. For the Atremata and Neotremata the terminology proposed by William King [1873, pp. 5 and 6] is adopted, and for the Protremata that used by Hall and Clarke [1892a, pp. 183–188] and given

under the terminology of Schuchert [1897, pp. 73–77]. I agree with Hall and Clarke [1892c. p. 21] that the terminology of the English authors has claims for its adoption. F. Blochmann [1900, p. 108] has proposed a set of terms for the muscles of the inarticulate brachiopods that has much to commend it. The terminology of Albany Hancock [1859, p. 800] has been extensively used by authors. The numbers in this correspond to the numbers given the terminology of King, Schuchert, and Blochmann.

Terminology of Hancock [*1859, p. 800*].

Inarticulates:	Articulates:
1. Anterior occlusors.	1. Anterior occlusors.
2. Posterior occlusors.	2. Posterior occlusors.
3. Divaricator.	3. Accessory divaricators.
4. Central adjustors.	4.} Ventral adjustors.
5. External adjustors.	5.}
6. Posterior adjustors.	6. Dorsal adjustors.
7. Peduncular.	7. Peduncular.

Terminology of King [*1873, pp. 5–6*].

1. Anterior lateral.	4. Transmedians.
2. Centrals.	5. Outside laterals.
3. Umbonal.	6. Middle laterals.

Terminology of Schuchert [*1897, pp. 73–75*].

1. Retractors.	5. Protractors (externals).
2. Adductors.	6. Protractors (middles).
3. Pedicle.	7. Diductors.
4. Rotators.	

Terminology of Blochmann [*1900, p. 108*].

1. Lateralis.	4. Obliquus internus.
2. Occlusor anterior.	5. Obliquus externus.
3. Occlusor posterior.	6. Obliquus medius.

DEFINITIONS.

Adductor muscles (*see Central muscles*).—The term adductor is used in the description of the muscles of the Protremata.

Anterior lateral (*retractor*) *muscles.*—In the Atremata these extend from the outer lateral margins of the visceral area in the ventral valve to its anterior extremity in the dorsal valve, and serve to readjust the dorsal shell.

Anterior region.—That portion of the shell in front of the transverse axis and opposite the pedicle opening.

Apex.—The place of initial shell growth. It may be the most posterior portion of the valve or it may be situated near the transverse axis.

Apical callosity.—The thickened boss at the inner side of the apex of the ventral valve of *Acrotreta* and other neotrematous genera, through which the pedicle tube or foramen passes.

Area.—See Cardinal area.

Articulate brachiopods.—In the orders Protremata and Telotremata the valves articulate by means of teeth and sockets. In some Atremata rudimentary articulation is also developed. (See p. 307.)

Atremata.—Primitive inarticulate calcareophosphatic brachiopods with the pedicle emerging more or less freely between the two valves. For a more detailed description see "Classification of Cambrian Brachiopoda," page 321.

Brachia.—The fleshy, coiled or spiral, ciliated appendages of brachiopods serving in water circulation and respiration.

Brachiocœle.—All of the anterior half of the valves outside of the anterior portion of the parietal band. (After King.)

Cardinal area.—A more or less well developed triangular area on each side of the delthyrium, distinctly set off from the general surface of the shell. It is best developed on the ventral

valve of articulate brachiopods, but is also present on the dorsal valve, and generally in a rudimentary condition in many inarticulate species. When the area is rudimentary it is often called a false or pseudo-area (Pl. II, figs. 1 and 7a; Pl. III, figs. 2a and 6b; Pl. V, figs. 1d at a; Pl. VI, figs. 1″ and 3b). The area of some of the inarticulate genera is frequently divided by a line between the delthyrium and the outer margin; in such areas the line is called the flexure line, owing to the slight interruption in the striæ of growth (Pl. VIII, fig. 1d at f), and the spaces separated by the flexure line are called the inner and outer lateral spaces of the area. (See Deltidium and Foramen, and p. 303.)

Cardinal extremities.—The terminations of the hinge line.

Cardinal muscle scar.—A large scar within which the posterior, anterior lateral, and transmedian muscles were attached.

Cardinal process.—A variously modified apophysis situated posteriorly at the center of the hinge of the dorsal valve in articulate brachiopods. To it are attached the diductor muscles, which by their contraction serve to open the valves anteriorly. (See p. 306.)

Cardinal slopes.—The inclined surfaces extending from the umbonal slopes to the hinge margins.

Central (adductor) muscles.—In the Protremata and Telotremata these muscles have their ventral insertion one on either side of the central axis, between the diductors. In passing to the dorsal valve they divide into four, and produce in that shell the two pairs of principal scars known as the anterior and posterior centrals. By contraction these muscles close the shell. In the Neotremata they are the essential muscles, the anterior centrals closing the valves, while the posterior pair serves to open the valves. In the Atremata there is a simple pair of centrals placed near the anterior extremity of the visceral area.

Chilidium.—A dorsal plate, in appearance similar to the deltidium, covering the exterior portion of the cardinal process in many Protremata. Its development does not begin until early neanic or later growth, and it is probably secreted by the dorsal mantle lobe. In the Atremata and Neotremata a similar plate, continuous with the dorsal cardinal region of the shell, is named the pseudochilidium. (See p. 306.)

Crura.—Processes on the dorsal hinge plate of the Telotremata and some Protremata, to which are attached the fleshy brachia and brachidia. These usually form the inner walls of the dental sockets, and may be supported by septal plates.

Cruralium.—The dorsal equivalent of the ventral spondylium. (See p. 309.)

Delthyrium.—The triangular aperture transecting medially the ventral cardinal area, or the posterior surface from the apex to the posterior margin of the ventral valve, through some portion of which the pedicle passes. It has also been termed the *fissure* or *foramen*. The delthyrium may or may not be closed either by a calcareous deltidium or a phosphatic pseudo-deltidium. (See p. 305.)

Deltidium.—A plate more or less continuous with the cardinal margin of the ventral valve and covering the delthyrium in Atremata, Neotremata, and Protremata. When present in inarticulate brachiopods it is called the pseudodeltidium. In the Protremata, in which it is always more calcareous, thicker, and more sharply defined, it is called the deltidium or the pseudochilidium. (See p. 305.)

Dental plates.—Vertical plates supporting the teeth of the ventral valve in articulate brachiopods. (See p. 310.)

Dental sockets.—Excavations in the dorsal cardinal margin of articulate brachiopods, in which the teeth of the ventral valve articulate. The inner wall of the socket is elevated and forms the base of the crural plate.

Diductor muscles.—In the Protremata and Telotremata the principal pair of diductor muscles has the larger end attached to the ventral valve near the anterior edge of the visceral area, and the other end has its insertion on the anterior portion of the cardinal process. By contraction these muscles open the valves.

Dorsal valve.—Usually the smaller and imperforate valve and the one to which the brachia are always attached. *Brachial, hæmal, socket,* and *entering valves* are other terms more rarely employed.

Ephebic.—Designating the mature shell.

False area.—See Cardinal area.

Flexure line.—See Cardinal area.

Foramen.—A small circular passage through the deltidium, either below or at the apex of the ventral valve. Sometimes the foramen encroaches by pedicle abrasion on the umbo of the ventral valve. (See p. 314.)

Foraminal tube.—The pedicle opening through the ventral valve of neotrematous genera. (See Pl. LVIII, fig. 5b.)

Genital markings.—Radial markings or pits within the posterior portion of the visceral space, indicating the position and extent of the genitals.

Gerontic.—Designating old age. It is indicated in the ontogeny of many species of brachiopods by extreme thickness of the valves, obesity, or by numerous crowded growth lines near the anterior margin, a condition which sometimes produces truncation and absence of striæ at the margin. (See p. 315.)

Heart-shaped cavity.—Central depressed portion of visceral area (Mickwitz). (See Pl. VII, figs. 9, 11, and 12 at x; also figs. 1, 2, and 8.)

Hinge line.—The line along which articulation takes place. Also sometimes developed among inarticulate brachiopods.

Inarticulate brachiopods.—In the orders Atremata and Neotremata the valves do not, as a rule, articulate by means of teeth and sockets, as is the case in the articulate orders Protremata and Telotremata.

Lateral areas.—That portion of the shell on each side of the central axis.

Listrium.—In some Neotremata a plate closing the progressive track of the pedicle opening or pedicle cleft posterior to the apex of the ventral valve. (See p. 306.)

Longitudinal axis.—A median line through the shell from the beak to the opposite margin.

Median septum.—An internal vertical plate commonly developed along the longitudinal axis and between the muscles of the ventral valve. Sometimes there is also a dorsal median septum. Lateral septa are rarely developed.

Middle lateral muscle scar.—See Outside and middle lateral muscles. .

Neanic.—Designating youthfulness, or the stage in which specific characters begin to develop.

Neotremata.—Circular or oval, more or less cone shaped, inarticulate calcareophosphatic brachiopods with the pedicle opening restricted throughout life to the ventral valve. For a more detailed description see "Classification of Cambrian Brachiopoda," page 323.

Nepionic.—Designating the smooth shell stage succeeding the protegulum.

Outside and middle lateral (protractor) muscles.—In the Obolidæ one pair has the ventral ends fastened at the anterior extremity of the visceral area, extending backward and inserted near the lateral margin of the dorsal valve, outside the transmedians. A second pair originates just behind the centrals of the ventral valve and is inserted posterior to the first pair. These muscles draw the dorsal valve forward.

Parietal band.—The point of attachment of the muscular wall surrounding the visceral area.

Pedicle.—The flexible muscular organ of the ventral valve by means of which brachiopods may be attached to extraneous objects.

Pedicle furrow.—The external furrow adjoining the foramen or pedicle opening in certain neotrematous genera. (See Pl. LXXXIII, figs. 1 and 2; Pl. LXXXIV, figs. 1 and 5c.)

Pedicle groove.—The median groove on the cardinal areas of the valves, formed by the pedicle extending through the posterior margin of the valves when they were closed.

Pedicle muscles.—In the Protremata and Telotremata one pair originates on the ventral valve at points just outside and behind the diductors and another on the dorsal valve behind the posterior centrals, while the opposite ends of both are attached to the pedicle. Besides these there is an unpaired muscle lying at the base of the pedicle, attaching it closely to the ventral valve.

Pedicle opening.—See Delthyrium.

Pedicle tube.—See Foraminal tube.

Platform.—An internal median thickening of the shell elevating the muscles. Seen in certain families of the Atremata and more rarely in the Neotremata. (See Spondylium and pp. 307 and 309.)

Pleurocœles.—Areas between the parietal band and the outer posterolateral margins. (After King.)

Posterior region.—That portion of the shell back of the transverse axis and toward the beak or apex.

Protegulum.—The initial shell of brachiopods. It is smooth and of microscopic size, in outline being semicircular or arcuate and without cardinal areas.

Protractor muscles.—See Outside and middle lateral muscles.

Protremata.—Articulate calcareous brachiopods with the pedicle opening restricted to the ventral valve throughout life or during early growth. Pedicle aperture modified by the deltidium. Brachia unsupported by a calcareous skeleton but nearly always by a crura of variable length. For a more detailed description see "Classification of Cambrian Brachiopoda," page 325.

Pseudo-area.—See Cardinal area.

Pseudochilidium.—See Chilidium.

Pseudocruralium.—Dorsal equivalent of pseudospondylium.

Pseudodeltidium.—The convex medial portion continuous with the ventral cardinal areas in Atremata and Neotremata. (See Deltidium.)

Pseudopedicle groove.—See Pedicle groove.

Pseudospondylium.—See Spondylium.

Retractor muscles.—See Anterior lateral muscles.

Septal plates.—Plates supporting the crural processes, also known as *crural plates*. (See p. 310.)

Sessile spondylium = Pseudospondylium.

Splanchnocœle.—The area within the parietal band. (After King.)

Spondylium.—A plate in some articulate brachiopods, mainly the Pentameracea, formed by the union of converging dental plates, to the upper surface of which are attached the adductor, diductor, and pedicle muscles. The spondylium may rest upon the ventral valve or may be supported by a median septum. The spondylium appears to be first indicated in the articulates by a thickening of the shell of the ventral valve beneath the umbonal region so as to form an area upon which all the muscles of the valve have their points of attachment. In *Billingsella* this is beautifully illustrated by *B. exporrecta* (Pl. LXXXVIII, figs. 1d, 1e, and 2a) and *B. plicatella* (Pl. LXXXVI, figs. 3i, 3k, and 3m). In its development the spondylium is foreshadowed in the Atremata by the so-called platform of *Elkania* (Pl. LI, figs. 1 and 1a) and by the still more primitive form in *Obolus* (Pl. VI). For the purpose of reference the rudimentary spondylia attached directly to the inner surface of the valve, as in *Billingsella*, may be called pseudospondylia (sessile spondylia, Ulrich), and those free or supported by a septum or septa, spondylia. In the Atremata the homologous equivalent has been known as the platform. In *Obolus*, *Elkania*, etc., there is sometimes developed in the dorsal valve a plate similar in appearance to the spondylium, but different in origin; this is known as the cruralium. (See p. 307.)

Teeth.—Two processes of the ventral valve of articulate brachiopods, serving for articulation. (See p. 307.)

Telotremata.—Articulate Brachiopoda with the pedicle opening shared by both valves in nepionic and early neanic stages, usually confined to one valve in later stages, and becoming more or less modified by deltidial plates in ephebic stages. Brachia supported by calcareous crura, loops, or spiralia. Prodeltidium absent. (After Schuchert.)

Transmedian (rotator) muscles.—In the Obolacea these are situated posteriorly just in advance of the umbonal muscle, two on one side and one on the other. By their contraction the dorsal valve turns alternately, first in one direction and then in the other.

Transverse axis.—A line through the shell from right to left midway between the beak and anterior margin. (See Longitudinal axis.)

Trapezoidal area.—The area on each side of the heart-shaped cavity in *Obolus* in which the outside and middle lateral scars and central muscle scars were attached. (See Pl. VII, figs. 10 and 12.)

Umbo.—The elevated or prominent portion of the valve anterior to the apex.

Umbonal cavity.—The hollow space in the interior of the shell beneath the umbo.

Umbonal muscle.—A single muscle situated in the umbonal region of most Atremata. By its contraction the valves are opened anteriorly. In *Obolus* this muscle divides toward the ventral valve.

Umbonal slopes.—The inclined surfaces about the umbo and opposite the cardinal slopes.

Vascular (pallial) sinuses.—Two convergent or divergent primary sinuses of the circulatory system, traversing the mantle and originating in the posterior medial region. They usually have numerous secondary (lateral and peripheral) branches, and both often leave impressions in the shell. (See p. 311.)

Ventral valve.—Usually the larger valve situated on the ventral side of the animal. Among articulate brachiopods the valve is usually easily distinguished by the presence of a delthyrium or pedicle opening through which the pedicle is protruded. In many atrematous genera the ventral valve is not readily distinguished. When the shell is cemented to foreign bodies it is always by the ventral valve. It is usually the larger and deeper of the two valves. *Pedicle, larger, dental, neural,* and *receiving valves* are synonymous terms.

Visceral area.—The posterior region of the interior of the valves between the pallial sinuses; in general the immediate area of the median muscle tracks.

Visceral cavity.—Visceral area.

THE BRACHIOPOD SHELL.

STRUCTURE.

GENERAL STATEMENT.

The general structural characters of the shell of the Ordovician and later brachiopods have been so fully described by authors that it does not appear to be necessary or desirable to repeat them. The student will find a full description given by Hall and Clarke in their "Introduction to the study of the Brachiopoda" [1892a, pp. 150–225].

Some of the more important works that contain data on the structure of the shell are those of Hancock,[a] King,[b] Carpenter,[c] Davidson,[d] and Mickwitz.[e]

The greater proportion of the Cambrian brachiopods are largely corneous or chitinous. These are restricted to the inarticulates, but the inarticulates of the Cambrian do not all possess corneous shells. Mickwitz has shown [1896, pp. 102–142] that the shells of *Obolus* and its subgenera are essentially the same as those of *Lingula* in composition and structure. In both the shells are composed of successive calcareous and corneous lamellæ that vary in thickness and structure. The calcareous lamellæ are prismatic and crossed by minute tubules; the corneous lamellæ are compact and imperforate.

Hall and Clarke [1892a, p. 175], in speaking of the shells of the articulate brachiopods, say:

> Among the articulate genera, under favorable preservation, there may be distinguished three distinct calcareous shell layers; an inner prismatic or fibrous layer, which constitutes the greater portion of the shell; above this is a thin lamellar layer, and the outer surface of the shell is covered by a tenuous epidermal film or periostracum. When the shell is punctate the tubules open on the inner surface in narrow apertures, whence they widen upward, abruptly expanding in the lamellar layer, at whose upper margin they terminate. They do not pierce the periostracum.

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[a] Hancock, A., On the organization of the Brachiopoda, 1859, pp. 791–869.
[b] King, W., On some characters of *Lingula anatina*, 1873, pp. 1–17.
[c] Carpenter, W. B., On the intimate structure of the shells of Brachiopoda, 1853, pp. 23–45.
[d] Davidson, T., On the classification of the Brachiopoda, 1853, pp. 41–136.
[e] Mickwitz, A., Ueber die Brachiopodengattung *Obolus*, 1896.

Among the calcareous, inarticulate brachiopods the shell of the Cambrian genus *Obolella* shows a dense, compact, slightly lamellated structure made up of a granular groundmass pierced by extremely small tubules or pores. The substance of the shells of *Rustella* and *Yorkia* is unknown, but from the character of the casts and the fact that the corneous shells of *Micromitra* in the same matrix are preserved it is probable that it was calcareous. The shells of *Quebecia*, *Trematobolus*, and *Dearbornia* are also calcareous.

In *Kutorgina* and *Schuchertina*, forms that may be referred to either articulate or inarticulate genera, the shells appear to be calcareous, compact, and without fibrous structure. Hall and Clarke, when speaking [1892a, p. 174] of the composition of the shell of the fossil linguloids, say:

> In the group of fossil linguloids, beginning with *Lingula*, passing through *Lingulops* and *Lingulasma* to *Trimerella* and its allies, there is a regular increase in the relative amount of calcareous matter in the shell, so that the Trimerellas, which are large and ponderous shells, seem to have wholly lost their corneous matter.

The predominance of corneous or calcareous shell matter does not appear to be of more than generic importance in the classification of the brachiopods. It is true that the known articulate genera are all calcareous, but it is equally true that among the inarticulate group calcareous shells occur. Alteration, replacement, and removal of original shell substance have changed the shell of so many species that other characters must be depended on for classification.

MICROSCOPIC STRUCTURE.

In previous work on the Cambrian Brachiopoda, except in the cases above cited, practically no attention was paid to the microscopic shell structure. The importance of this feature in the classification of later species suggested the possible value of a microscopic study of the earlier forms, and at my request Mr. E. O. Ulrich and Mr. R. S. Bassler prepared thin sections and also assisted in the preparation of figures 1–15 (pp. 298 and 299) and in the preliminary study of the sections.

The preparation of thin sections of these early brachiopods is accompanied with difficulties which, together with the lack of sufficiently extensive collections, have undoubtedly prevented previous study along the same line. Specimens suitable for sectioning, especially of the calcareous forms, are not at all common, and when they do occur they are almost invariably buried in the rock and are so thin that the parting of the inclosing matrix does not leave sufficient shell substance for the preparation of sections. In the present work the specific identity of a shell was first determined by uncovering about one-half the valve, and the other half, still embedded in the matrix, was then used in making the section. The structural features are often restricted to individual lamellæ and the right zone for microscopic examination was determined simply by close observation as grinding proceeded. Both vertical and tangential sections were prepared, the former cutting the shell at right angles and the latter cutting the shell in planes more or less parallel to the layers or lamellæ of which it is composed. The most interesting results were obtained from the tangential sections, as the thin shells showed little decided structure in vertical sections.

Description of figures 1–15a.[a]

Billingsella plicatella Walcott [1905a, p. 240]:

FIGURE 1.—Diagrammatic sketch of a small portion of a tangential section, × 200. The granular groundmass, with small pores and tubules 4 or 5 times their own diameter distant from each other, is also typical of other members of the Billingsellidæ. Upper Cambrian, Gallatin Valley, Montana.

Dalmanella subequata (Conrad) [1843, p. 333]:

FIGURE 2.—Photograph of a tangential section, × 35, showing the fibrous structure and comparatively large pores. Ordovician, St. Paul, Minnesota.

Kutorgina cingulata (Billings) [1861b, p. 8]:

FIGURE 3.—A small portion of the tangential section shown in fig. 8, × 200. The minute structure of this and the following species is essentially the same as that shown in fig. 5, the only difference being the closer arrangement of the pores. Lower Cambrian, Swanton, Vermont.

Obolus apollinis Eichwald [1829, p. 274]:

FIGURE 4.—Small portion of tangential section, × 200. The minutely porous granular structure is beautifully shown in this species, in which the pores are arranged more closely than in any other observed. Upper Cambrian, *Obolus* sandstone, Esthonia, Russia.

Billingsella coloradoensis (Shumard) [1860, p. 627]:

FIGURE 5.—Photograph of horizontal thin section enlarged fifty diameters. This shows the characteristic granular groundmass of the Cambrian Billingsellidæ. Upper Cambrian, Morgan Creek, Burnet County, Texas.

Nisusia festinata (Billings) [1861b, p. 10]:

FIGURE 6.—Photograph of horizontal thin section enlarged fifty diameters. This section shows a granular groundmass in which faint indications of small pores or tubules may be seen with a high power. Lower Cambrian, 2 miles east of Swanton, Vermont.

Eoorthis remnicha (N. H. Winchell) [1886, p. 317]:

FIGURE 7.—Photograph of horizontal thin section enlarged fifty diameters. This section shows the same type of groundmass as that illustrated by fig. 6. Upper Cambrian, Cold Creek Canyon, Burnet County, Texas.

Kutorgina cingulata (Billings) [1861b, p. 8]:

FIGURE 8.—Photograph of horizontal thin section showing granular shell substance. There are few slight indications of pores. Lower Cambrian, Swanton, Vermont.

Dalmanella multisecta (Meek) [1873, p. 112]:

FIGURE 9.—Horizontal thin section enlarged fifty diameters. This shows the fibrous structure of the shell penetrated by numerous fine tubules. Ordovician, Eden shale, Cincinnati, Ohio.

Dalmanella parva (de Verneuil) [1845, p. 188]:

FIGURE 10.—Horizontal thin section showing fibrous structure; also section of the tubules that penetrate through the shell. Middle Ordovician of Russia.

Syntrophia lateralis (Whitfield) [1886, p. 303]:

FIGURE 11.—Horizontal thin section enlarged fifty diameters, showing the arrangement of the pores in lines that radiate from the apex toward the margin. Lower Ordovician, Beekmantown, Fort Cassin, Vermont.

Plectorthis plicatella (Hall) [1847, p. 122]:

FIGURE 12.—Horizontal thin section enlarged fifty diameters. This section shows the fibrous structure so characteristic of the Ordovician orthoids. Ordovician "Lorraine shaly limestone," Cincinnati, Ohio.

Huenella abnormis (Walcott) [1905, p. 289]:

FIGURE 13.—Horizontal thin section enlarged fifty diameters. The pores in this genus are smaller than in *Syntrophia*, but their arrangement is essentially the same and shows the line effect characteristic of the Pentameracea. Upper Cambrian, Gallatin Valley, Montana.

Obolella crassa (Hall) [1847, p. 290]:

FIGURE 14.—Horizontal thin section enlarged fifty diameters. This shows the fine granular groundmass, with an indication in the upper left side of the section that a surface ornamentation has been cut across. Lower Cambrian, Bic, Canada.

Obolus apollinis Eichwald [1829, p. 274]:

FIGURES 15 and 15a.—Transverse vertical thin sections enlarged so as to show the lamellæ and the presence of a large tubule that appears to have more or less imperfectly penetrated through the shell. Upper Cambrian, *Obolus* sandstone, Russia.

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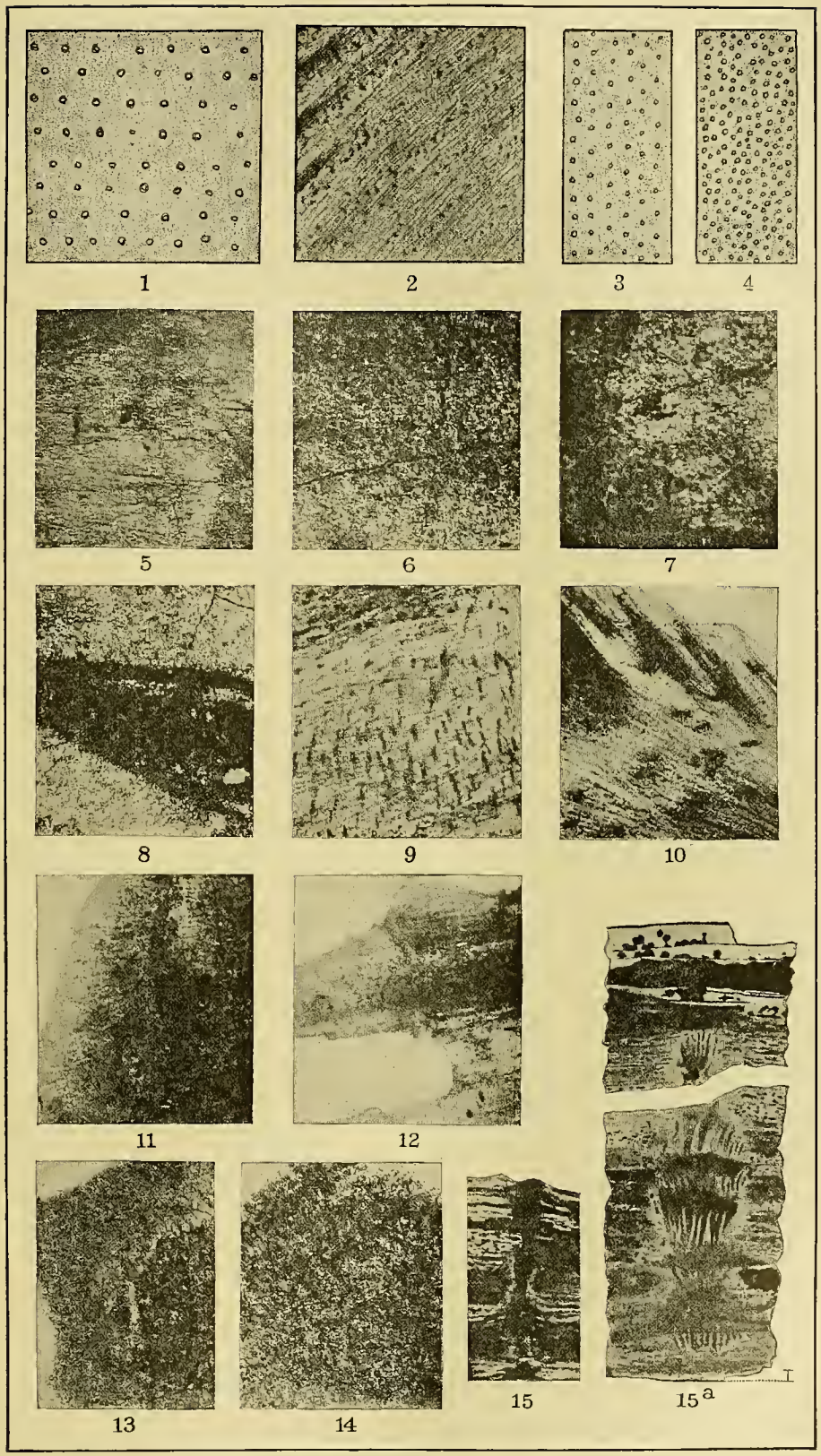
[a] Figs. 1–4 are copied from figs. 2–5 on p. 151 of a preliminary paper on the classification of the Cambrian Brachiopoda [Walcott, 1908c]. Figs. 5–15 and 15a are copied from figs. 1–12, Pl. XII, of the same paper.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The general resemblance of the Cambrian eoorthoids to certain Ordovician Protremata is so striking and the lines of descent so suggestive that particular attention was devoted to this group. Examination, however, brought out the fact that this apparent relationship disappears when the shell structure of the two groups is compared.

Sections of the shells of members of the Billingsellidæ, of which figure 1 is typical, all show a lamellar structure with indications of more or less numerous, scattered, very minute pores or tubules passing without interruption through one lamella. In some sections the spots indicating the tubules are arranged in rows radiating from the beak of the shell to the margins, but no other regular arrangement can be seen. The great mass of the shell is made up of a compact, finely granular base with dark spots and occasional minute crystals of calcite, a groundmass which, under the microscope, appears very much like that of a fine argillaceous shale.

The Ordovician Protremata have a clearer, more crystalline aspect or color than the Cambrian Billingsellidæ, a difference which probably indicates either a purer lime composition for the former or more probably a higher percentage of calcium phosphate for the latter. In chemical aspect the shells of the Billingsellidæ appear to resemble those of the Atremata and Neotremata more closely than do the Orthidæ. (Compare figs. 1, 3, and 4 with 2.)

Analyses of the respective shells would be necessary to prove these relations, but they are interesting subjects for investigation in view of the possible derivation of the Billingsellidæ from the Atremata.

In the Cambrian articulate genera, with the possible exception of *Syntrophia* and *Huenella*, the minute, fibrous structure so characteristic of most if not all orthoids is entirely absent. (Compare figs. 1 and 2.) *Syntrophia* and *Huenella*, however, greatly resemble each other. Thus sections of the shell of *Huenella abnormis* of the Upper Cambrian (fig. 13) and *Syntrophia lateralis* of the Lower Ordovician (fig. 11) show the same radial arrangement of the pores seen in the Billingsellidæ, but the shell structure is fibrous and the rows are coincident in direction with the fibers. On closer study this apparently fibrous structure can be resolved into more or less parallel bands or walls of shell substance separating rows of closely arranged, rectangular, porelike spaces. These spaces may be seen distinctly in thick sections, but they disappear when the section is made sufficiently thin to give a clear image under very high power. Sections of the linguloid genera were also prepared and studied, but the thinness of the shells and their phosphatic character prevented very satisfactory results. The irregular large tubules mentioned by Mickwitz [1896, p. 106] are beautifully shown in sections of *Obolus apollinis* before me.

Some of the tubules penetrate several lamellæ of the shell and suggest the tubules of some of the orthoids. (See figs. 15 and 15*a*.) The same general structure, with the exception of the larger tubules, appears to be characteristic of all of the corneous shells of the Atremata and Neotremata, and, so far as known to me, of all of the Cambrian corneous shells.

Figures 5–14 are from photographs which have not been retouched, so that personal equation may be eliminated. Unfortunately, higher magnifications could not be used without a loss of clearness, but even at the present magnification these views show decided differences in structure.

In conclusion, it appears that the Cambrian Billingsellidæ are further removed from the Ordovician and later Protremata than has hitherto been suspected, the microscopic shell structure in the former being of granular material pierced by small pores and in the latter of fibrous material. On the other hand, the microscopic structure of the Cambrian and later Pentameracea is so similar that an unbroken line of descent is indicated.

SURFACE ORNAMENTATION.

GENERAL STATEMENT.

The known protegulum of all brachiopods is smooth, and the shells have usually advanced well into the nepionic stage of growth before the outer surface is ornamented to any considerable degree. Many species of Cambrian inarticulate brachiopods (especially the Obolacea) remain smooth through all stages of growth, with the exception of lines and varices of growth. Many of them, however, have some form of ornamentation, and some of the most ornate types of surface,

such as that of *Micromitra* (*Iphidella*) *pannula* (Pl. IV) and *Botsfordia cælata* (Pl. LIX), were fully developed in Lower Cambrian time.

I have given much attention to the question of the value of surface ornamentation for the purposes of systematic classification among the Cambrian brachiopods, and have concluded that only in cases where a distinctive surface is persistent for a considerable period can it be considered of more than specific value. In one instance I have given the type of surface found on *Obolus* (*Westonia*) *aurora* (Pl. XLVI, fig. 1h) a subgeneric value, but its wide range of variation makes me doubtful of its utility.

ATREMATA.

So far as known, the outer surface of *Rustella*, the most primitive type of brachiopod known (Pl. I, figs. 1, 1a–e), is marked only by concentric growth lines. Among other genera referred to the Paterinidæ, *Volborthia* (Pl. I, figs. 6, 6a–e) has only concentric growth lines on the outer surface, although it has numerous radiating lines on the inner laminations of the shell. On the outer surface in the genera *Mickwitzia* (Pl. VI) and *Helmersenia* (Pl. LXIII, figs. 7, 7a, and 7e) are found concentric and radiating lines and small tubercles (apparently rudimentary spines) that are ornamental in their arrangement and effect, but it is in *Micromitra* that the greatest variety and most highly ornamented surfaces appear. Species that have a simple type of surface, marked only by concentric lines of growth, are grouped under the subgenus *Paterina* (Pl. II), while those having an ornate surface (Pl. IV) are included in the subgenus *Iphidella*. Transition forms, intermediate in surface ornamentation between the two extreme types, are referred to *Micromitra*, since the type species, *M. sculptilis*, has this intermediate form of surface. The species *Micromitra* (*Paterina*) *pealei* (Pl. III, figs. 3, 3a–e) approaches closely to *Micromitra sculptilis* (Pl. III, figs. 5, 5a, and 5e) but is not quite so highly ornamented. *Micromitra* (*Iphidella*) *pannula* and its varieties (Pl. IV) have a highly ornate surface, and the species has both wide geographic distribution and stratigraphic range. It is abundant in the Middle Cambrian and it also occurs in the upper portion of the Lower Cambrian section in Nevada. The oldest known brachiopod from British Columbia, *Micromitra* (*Iphidella*) *louise*, which occurs 3,090 feet down in the Lower Cambrian terrane, has an ornamented surface much like that of *M.* (*I.*) *nyssa* (Pl. III, fig. 9), which occurs at the summit of the Lower Cambrian in the same stratigraphic section.

None of the Obolidæ of the Lower Cambrian is known to have an ornamented surface, but in the Middle Cambrian many species show, in addition to the concentric striæ and lines of growth and the radiating striæ and ridges, a variously pitted and granulated surface primarily formed by the crossing of the radiating and concentric ridges by oblique undulating ridges.

What I have called the *Westonia* type of surface (Pls. XLVI and XLVII) is the most common. A variety of this type where the lines are transverse is more rarely seen (Pl. XLIX, fig. 1f and 1g). The *Westonia* surface is not confined to *Obolus* (*Westonia*), as it occurs among the Neotremata in the genera *Obolella* (*Glyptias*), *Botsfordia*, *Acrothele*, *Acrotreta*, and *Acrothyra*. (See description of *Obolus* (*Westonia*), p. 450.) It is also present on Ordovician and later brachiopods and it is known on *Lucinia divaricator* and other pelecypods. [See Winchell and Schuchert, 1895, pp. 345–346.]

In *Obolus* (*Acritis*) (Pl. XIII, fig. 3) the irregular, undulating, and more or less inosculating concentric ridges suggest one of the rudimentary characters of some types of the *Westonia* surface, but their origin was probably different. The surface of *Lingula cincta* Barrande [1879b, Pl. CV, figs. 1A, 2A, and 2f], from Étage E (Ordovician), is much like that of *Obolus* (*Acritis*) *antiquissimus*, but it is probably an illustration of the persistence of a form of surface sculpture through several geologic formations and a corresponding period of time.

The surface of *Lingula eximia* Barrande [1879b, Pl. CV, block 1] is highly ornate. The figure is introduced on Plate XXXII, fig. 3, as a possible type that may be found to have existed in late Cambrian time. *Obolus* (*Mickwitzella*) *siluricus* (Pl. XV, figs. 1b and 1c) has fine crenulations on the front side of certain concentric ridges, a type of ornamentation that is unknown among the Cambrian brachiopods except in this one Upper Cambrian species.

The presence of spines in inarticulate genera is of rare occurrence. The oldest known indication of their presence in other families than the Paterinidæ is on *Bicia gemma* (Pl. L, fig. 1a) and *Nisusia festinata* (Pl. C, fig. 1) of the Lower Cambrian. The Middle Cambrian *Nisusia alberta* (Pl. C, fig. 3c) has a series of strong spines, and, in the Upper Cambrian, *Acrotreta spinosa* (Pl. LXXIX, figs. 4a, 4b, and 4g), *Schizambon* (Pl. LXXXIV, figs. 1d and 3a), and *Helmersenia ladogensis* (Pl. LXIII, fig. 7e) appear to have had a spinose surface.

NEOTREMATA.

Obolella (Pls. LIV and LV) has, so far as known to me, only concentric lines and ridges of growth, but the surface of *Botsfordia* is usually quite ornate. The granular type is best shown by *B. granulata* (Pl. LVII, fig. 4r) and *B. cælata* (Pl. LIX, figs. 1h and 1o), and the pitted or reticulated type, formed by the crossing of obliquely concentric ridges, by *B. pulchra* (Pl. LXII, figs. 5, 5a–f, and 5k). *Botsfordia? barrandei* (Pl. LVII, figs. 7, 7a, and 7b) appears to have a smooth surface or one marked only by concentric growth lines.

Trematobolus of the Siphonotretidæ is like *Obolella* in having a plain surface, but in *Yorkia orientalis* (Pl. LXXXII, fig. 3a) the surface is of the reticulated type and resembles that of *Micromitra* (*Iphidella*) *pannula* of the Atremata. *Siphonotreta* has a finely granulated surface (Pl. LXXXI, figs. 6 and 6a), also a pustulose surface (Pl. LXXXI, figs. 5 and 5a). The latter type is found in the Atremata in *Mickwitzia* (Pl. VI, fig. 2) and the granulated surface is present in *Botsfordia* (Pl. LVII, fig. 4r) of the Obolellidæ. The surface of *Schizambon* (Pl. LXXXIV, figs. 1d and 3a) differs from all other genera of the Neotremata except *Acrotreta* (Pl. LXXIX, fig. 4g) in being spinose.

The surface of *Acrothele* varies in almost the same manner as that of *Micromitra*. Species occur with only concentric growth lines, as in *Acrothele subsidua* (Pl. LX, figs. 1c, 1d, and 1i), or the same species may have a few radiating ridges (Pl. LX, figs. 1a, 1b, and 8). The radiating ridges may be characteristic of some forms of the adult shells of the species, as in *A. matthewi multicostata* (Pl. LXI, figs. 5, 5a–c). In addition to these, there may be an irregular more or less inosculating series of fine concentric ridges, as in *A. avia* (Pl. LXII, fig. 1j); a finely granular surface, as in *A. coriacea* (Pl. LVI, fig. 1g); a more distinctly and strongly granular surface, as in *A.* (*Redlichella*) *granulata* (Pl. LVI, fig. 2g) or *A. prima costata* (Pl. LXI, fig. 4d). A pitted surface is sometimes formed by the crossing of obliquely concentric narrow ridges, as in *A. bella-punctata* (Pl. LVII, fig. 3b).

Only a few species of *Acrotreta* have more than the smooth surface with concentric lines. I was greatly surprised when I found a shell showing a spinose surface, *A. spinosa* (Pl. LXXIX, figs. 4a, 4b, and 4g), and again when I found a reticulated surface, *A.? cancellata* (Pl. LXXIX, fig. 5a). Both species are from the fauna of the Cordilleran sea; *A. spinosa* developed in late Cambrian time and *A.? cancellata* in early Ordovician time. The closely related genus *Acrothyra* has a very fine *Westonia* type of surface (Pl. XLVII) that can be seen only with the aid of a strong lens.

PROTREMATA.

The ornamentation of the surface of the shells of Protremata is usually in the form of radiating striæ, lines, and ridges of varying size and number, with concentric lines and ridges of growth. The radiating striæ, lines, and incipient ridges or plications are usually first seen on the inner laminations of the shell, and often this occurs in species that do not show it on the outer surface of the shell. This is beautifully shown in the atrematous genera *Mickwitzia* (Pl. VI, figs. 1k and 1 l), *Obolus* (Pl. VIII, figs. 1i and 2; Pl. X, figs. 2 and 2e), *Obolus* (*Westonia*) (Pl. XII, figs. 7 and 7c; Pl. XLVII, figs. 1a, 1g, and 1m), *Obolus* (*Lingulobolus*) (Pl. XVI, figs. 1, 1b, 2c, 2f, 2h, and 2i), *Lingulella* (Pl. XVII, fig. 1 l; Pl. XXXI, figs. 6e and 6g; Pl. XXXVIII, figs. 2d and 2f), *Lingulella* (*Lingulepis*) (Pl. XLI, figs. 1a–c, 1f–h, and 1j–m), and *Dicellomus* (Pl. LII, figs. 2c and 2h; Pl. LIII, figs. 1b, 1c, 2, 2a, 4a, 4d, and 4e). In *Bicia gemma* (Pl. L) the radiating lines and ridges occur on both the interior and exterior surfaces, and there are also elongated tubercles that suggest fine spines. In *Kutorgina granulata* (Pl. V, figs. 5b and 5c)

they are strong on the inner surface and less marked on the outer surface. Other species of *Kutorgina* (Pl. V) have a smooth, or only concentrically lined, surface. *Schuchertina cambria* (Pl. LI, figs. 6, 6a–m) has a fine series of internal radiating striæ and ridges, but the exterior surface is without them.

Among the Protremata the radiating ridges are present in most genera, although some species of a genus may not have them. In the Billingsellinæ a few species with smooth shells occur (Pl. LXXXVII, figs. 1, 1a–e, 7, 7a, 5, and 5a), but the greater number have both interior and exterior radiating ridges (Pls. LXXXVII–XC). Among the Nisusiinæ and Eoorthinæ all the species show more or less of external radiating lines and ridges; sometimes the young shells are nearly smooth (Pl. XCVIII, figs. 1f, 2b, and 5), but this in most cases is at a very young stage of growth. The Syntrophiidæ show variation from the smooth adult shells of *Syntrophia calcifera* (Pl. CIV, figs. 1, 1a–i) to the strongly costate shells of *Huenella texana* (Pl. CIII, fig. 1e). *Swantonia* (Pl. CIV, figs. 5 and 6) has numerous radiating costæ.

INTERLOCKING PLICATIONS.

Interlocking of the margins of the valves began as soon as plications or ribs first appeared on the shell. The wide variation in size and number in the same species (Pl. CIII, figs. 1, 1a–g) indicates that this character is, like that of surface ornamentation, of little more than specific value. In the description of the surface ornamentation of the Protremata (p. 302) reference is made to the order of appearance and the character of the ridges or plications among the Cambrian brachiopods.

CARDINAL AREA.

ATREMATA.

In the protegulum stage of the atrematous shells the posterior margins of the valve are not bent regularly inward toward each other and there are no indications on the surface of a cardinal area. There is a simple cleft, the length of which is dependent on the degree of rounding of the posterior margins. Among the genera and species referred to the order Atremata, the pseudodeltidium of *Rustella edsoni* (Pl. I, figs. 1b, 1c, 1e) is extremely rudimentary, if developed at all, and there is no trace of a thickened cardinal surface. The pedicle appears to have impressed itself on the shell to the extent of making a shallow furrow on the posterior inner margin of the rather thick shell of the two valves. In *Mickwitzia monilifera* (Pl. VI, fig. 1″) the pressure and movement of the pedicle against the vertical cardinal margin during the growth of the shell have had the effect of bulging it outward so as to produce a pseudodeltidium, but on neither of the valves is there a trace of a cardinal thickening. In *Helmersenia ladogensis* (Pl. LXIII, fig. 7d) a pseudodeltidium similar to that in *Mickwitzia* occurs on the ventral valve, and here also there is only a thickening of the posterior margin and not a true cardinal area. In the genus *Micromitra* the mechanical influence of the pressure of the pedicle on the ventral valve is much more pronounced; in *Micromitra* (*Paterina*) *bella* (Pl. II, figs. 1a and 1b) the pseudodeltidium is more clearly defined than in *Mickwitzia* or *Helmersenia*, and the concave arch of the cardinal margin for the protrusion of the pedicle is greater. In *Micromitra* (*Paterina*) *superba* (Pl. II, fig. 7) the excavation of the pseudodeltidium has increased, and in *Micromitra* (*Paterina*) *logani* (Pl. II, fig. 6b) and *Micromitra* (*Iphidella*) *pannula* (Pl. IV, figs. 1d, 2a″, and 2b′) the pseudodeltidium has been excavated to such an extent that there is nearly an open delthyrium. This difference in delthyrial openings must be due to variation in the thickness of the pedicle. Attention is called to the pseudodeltidium shown in figure 2a″, Plate IV, where the tripartite, longitudinal division recalls the pseudodeltidium of *Acrotreta nicholsoni* (Pl. LXXIII, figs. 1g and 1h). So far as known to me, no true cardinal area is present in any species of the Paterinidæ, though there may be a more or less marked thickening or bulging of the posterior margin of the valves to form a pseudodeltidium.

In the Obolidæ the vertical cardinal area is present in all known species, but in varying degree of development. It is slightly shown in *Delgadella* (Pl. XXIX, figs. 5, 5a, and 5b) and well defined in *Obolus prindlei* (Pl. XXVII, figs. 3a, 3b, 3c, and 3e), *Lingulella granvillensis*

(Pl. XXII, figs. 1 and 1b), *Lingulella nathorsti* (Pl. XXXI, figs. 1 and 1a), and *Lingulella schucherti* (Pl. XXI, fig. 6), all of which are from the Lower Cambrian. *Lingulella schucherti* is probably the oldest known species, unless it be *Delgadella lusitanica*. In *Dicellomus* the cardinal area of the ventral valve (Pl. LII, figs. 1c and 1d) is not unlike that of *Obolus*, except that short teeth (Pl. LII, fig. 1d) appear to have been developed, and that on the cardinal area of the dorsal valve (Pl. LII, fig. 1i) there is a socket-like groove on each side for the reception of the projection in the ventral valve. On other specimens of the area of the dorsal valve there are many minor depressions or crenulations (Pl. LII, fig. 1j), but no defined groove or socket. On the dorsal valve of another species the cardinal area (Pl. LIII, fig. 1) is not unlike that of the dorsal valve of *Obolus*. There is considerable variation in the details of form and size of the vertical cardinal areas of the various species of *Obolus*, its subgenera, and *Lingulella*, but it is all within the typical *Obolus*-like cardinal area as seen in *Obolus apollinis* (Pl. VII). A curious individual development or extension of the area is shown in some specimens of *Obolus namouna* (Pl. VIII, fig. 2a) and *O. rhea* (Pl. IX, fig. 1), where the posterior margin of the mantle appears to have been drawn farther forward inwardly and a thin deposit of shell made, so as to carry the front margin of the cardinal area far in advance of its usual position in the species of the genus. On *Bicia*, one of the oldest genera (Pl. L), the area is as strongly defined as it is in *Obolus* and its subgenera, and teeth or articulate processes are suggested. In *Elkania* (Pl. LI, figs. 1 and 1a) the cardinal area so merges into the thickened platform that it is not readily separable from it. I have referred to this as the internal cardinal area, or the area that is inclined inward from the plane of the margins of the valves and united by shell deposit to the interior of the shell. In *Neobolus* the internal cardinal area of the dorsal valve extends forward as a semicircular shelf (Pl. I, fig. 4b). It is a modified cardinal area on the plane of the margins of the valves, but in the adult it does not extend over the rounded posterior margin of the valve. The area of the ventral valve is unknown, but from the presence of an open delthyrium (Pl. I, fig. 4′) it is not probable that a well-defined cardinal area exists.

In the dorsal valve of *Lingulella granvillensis* (Pl. XXII, fig. 1d), *Lingulella helena* (Pl. XXIV, fig. 3c), *Obolus* (*Westonia*) *euglyphus* (Pl. XLVIII, fig. 1e) there is a strong undercut or opening beneath the area adjoining the pedicle furrow. This also occurs in the ventral valve of the last-mentioned species (Pl. XLVIII, figs. 1c and 1d) and in many species of *Obolus* and its subgenera and in *Lingulella*. In other species the area may be thickened so as practically to close up the space between it and the inside of the valve (Pl. VII).

In *Kutorgina* (Pl. V) the cardinal areas are in a very rudimentary condition, and comparable with the rudimentary cardinal areas of *Micromitra* (Pls. II, III, and IV). The general form and structure of *Kutorgina*, taken in connection with the rudimentary cardinal areas beneath the beaks of the valve, give the areas a significance that those of *Micromitra* do not possess. It is highly probable that a number of intermediate forms, in which the cardinal areas gradually obtained their more mature character, were developed between the type from which *Kutorgina* was derived and *Nisusia* and *Billingsella*, but nothing is known of such intermediate forms in the Lower Cambrian. *Schuchertina* (Pl. LI, figs. 6, 6a–m) appears to have been descendant from some atrematous type that may also have been the ancestral stock of *Kutorgina* and the forms that passed into *Nisusia* and *Billingsella*. *Schuchertina* is a primitive protrematous genus still preserving strong atrematous characters—or vice versa, according to one's point of view.

NEOTREMATA.

The cardinal areas of the valves of *Obolella* (Pls. LIV and LV) of the Lower Cambrian are essentially the same in appearance as those of *Obolus*, except that they are not usually so strongly developed. They may also be compared with the cardinal areas of *Bicia* (Pl. L), especially the projections on the inner angle adjoining the pedicle furrow. The narrow, thickened cardinal margin in the ventral valve of *Obolella* does not clearly show from the interior view, although such specimens as that illustrated on Plate LIV, figure 2h, indicate that the area is not so prominent as in the ancestral form. This is more clearly shown on Plate LIV, figure 2g. In

Botsfordia cælata (Pl. LIX, figs. 1e, 1f, and 1k) the cardinal areas are present but subordinate as compared with the areas of *Obolella*. They are still less in evidence in *Botsfordia granulata* (Pl. LVII, figs. 4g–m) and *Botsfordia pulchra* (Pl. LXII, figs. 5g–j). In *Neobolus* (Pl. LXXXI, figs. 2e–h) the reduction of the cardinal areas has progressed until they are no longer a marked feature of either valve. In *Trematobolus* (Pl. LXXXIII and Pl. LXXXIV, figs. 5a and 5b) the development of the pedicle tube is much more advanced than in *Obolella*, but the cardinal areas are here again a prominent feature; they are less clearly defined in *Yorkia* (Pl. LXXXII, figs. 1e–h), in which the pseudodeltidium of the ventral valve is developed (Pl. LXXXII, figs. 1b–c). In other forms of the Siphonotretidæ the cardinal areas as developed in the Obolidæ are not seen in the adult stages of growth.

It is interesting to note that the vertical thickened cardinal area is present in the oldest known brachiopod, *Trematobolus excelsis* (Pl. LXXXII, fig. 8), which occurs stratigraphically lower down in the Lower Cambrian of North America than any other species of brachiopod known to me. *Linnarssonella*, with its low false area and strongly marked interior of its valves, has also a well-defined cardinal area in some species (*L. modesta*, Pl. LXXVIII, fig. 8e; *L. girtyi*, Pl. LXXIX, figs. 1l, 1m, and 1r), in this feature suggesting that it is more primitive than either *Acrotreta* or *Acrothele*. *Quebecia* is a very ancient form, but so far as known it passed in the adult beyond the stage of having a vertical cardinal area. Nothing is known of the interior of *Discinolepis* of the Middle Cambrian, but in the dorsal valve of *Keyserlingia* the thickened cardinal area is a well-developed feature (Pl. LXXXI, fig. 4e). *Acrotreta* occasionally shows a vertical cardinal area in the dorsal valve (*A. definita*, Pl. LXIV, fig. 2d; *A. kutorgai*, Pl. LXV, figs. 3h–j; *A. curvata*, Pl. LXVIII, figs. 1k and 1l; *A. ophirensis*, Pl. LXXIV, fig. 1f; *A. ophirensis descendens*, Pl. LXXVIII, fig. 1c; and *A. marjumensis*, Pl. LXXVIII, fig. 2c). Other examples doubtless occur, but it appears that in both *Acrotreta* and *Acrothyra* the vertical cardinal areas are absent or so reduced as no longer to be a generic character; the same is to an even greater degree true of *Acrothele*. *Acrothele bellula* (Pl. LVIII, figs. 5c–h) has a defined cardinal area in the dorsal valve and a trace of one on the ventral valve; otherwise, only the false external area back of the pedicle opening is known to me among the species of *Acrothele*, its subgenus *Redlichella*, or *Schizopholis*. Nothing is known of a thickened vertical cardinal area in *Orbiculoidea* or *Philhedra*.

PROTREMATA.

Two of the earliest forms of the Protremata (*Billingsella* (Pl. LXXXV) and *Nisusia* (Pl. C)) both have a clearly defined cardinal area on the ventral valve, divided by a delthyrium that is more or less completely covered by a deltidium. These characters appear to be developed in the same manner as in the Inarticulata; in other words, they are the result of holoperipheral growth and pedicle pressure bulging the median region of the cardinal area. No deltidial plates are known in the Billingsellidæ. So far as known *Otusia* has an open delthyrium. The cardinal area of *Wynnia* (Pl. LXXXIX, fig. 4b) has a large, open delthyrium, with no trace of a deltidium in any of the four specimens from India. The figure shows a bit of shell at the top of the delthyrium, but this is not in place. The identification of the subfamily Rafinesquinæ by *Eostrophomena* is of doubtful value (Pl. XCV, figs. 6, 6a–b) and nothing is known of the area of the ventral valve. *Eoorthis* (Pl. XCI), *Orusia* (Pl. XCVIII), and *Finkelnburgia* (Pl. XCIII) have an open delthyrium in the ventral valve. The cardinal area of *Swantonia* (Pl. CIV, figs. 5 and 6) is unknown. *Huenella* has a clearly defined area on both valves and an open delthyrium (Pl. CIII, figs. 1c, 2g, 2i, and 3″).

DELTHYRIUM AND DELTIDIUM.

The development of the delthyrium from the simple *Rustella* stage, where it is scarcely more than a broad opening between the valves, to the definite form in the higher types of the Protremata, where it is either open or more or less closed by a deltidium, has been outlined in

connection with the notes on the cardinal areas. The evolution in the Atremata, Neotremata, and Protremata has been in the same direction, ranging from the open-fissured protegulum stage in pre-Cambrian time to the fully developed, clearly defined, subtriangular, usually convex pseudodelthyrium and deltidium. In *Acrotreta kutorgai* the cardinal area and deltidium of the dorsal valve are well defined (Pl. LXV, figs. 3i and 3j). I am inclined to think that the pseudodeltidia of the Atremata and Neotremata, as also the deltidia of the Protremata of the Cambrian, are all the result of holoperipheral growth and not of growth from a prodeltidial plate, as interpreted by Beecher [1892, p. 142].

The deltidia of the Protremata vary in size from the large deltidium of *Billingsella coloradoensis* (Pl. LXXXV, figs. 1n and 1o) to those in which the delthyrium is entirely open in the mature stages of the individual. The exact stage at which the rudimentary deltidia resulting from the holoperipheral growth of the shell begin to take on the more definite form shown in *Nisusia* (Pl. C) and *Billingsella* (Pl. LXXXV) is unknown.

From my studies of the Cambrian brachiopods I see nothing that leads me to the belief that in the Protremata the deltidium has a different origin from the pseudodeltidium of the Atremata. Whatever the significance of the prodeltidium or third shell plate of the Neotremata may be, it is plain from the many species of Atremata, Neotremata, and Protremata throughout the Cambrian that the pedicle openings tend to develop in two directions; resulting, first, in a more or less large open delthyrium, due in all probability to a thick and short peduncle filling up the space, and, second, in a more or less covered delthyrium (the covering being either the phosphatic pseudodeltidium or the calcareous deltidium), the peduncular opening being either between the two valves or reduced to a foramen limited to the ventral valve.

LISTRIUM.

Hall and Clarke [1892a, p. 153] deemed it important to apply the term listrium to the calcareous deposition or plate closing the progressive track of the pedicle opening or pedicle cleft posterior to the apex of the ventral valve. This feature is known only in *Orbiculoidea* among Cambrian genera of Brachiopoda. It has not been observed in the Siphonotretidæ.

PSEUDOCHILIDIUM.

The pseudochilidium is a convex plate closing the primitive aperture in the dorsal valve of Atremata and Protremata. It corresponds to the pseudodeltidium of the ventral valve and is formed about the dorsal side of the pedicle aperture.

CARDINAL PROCESS.

The cardinal process, like the crura, was evidently developed in the interval of progression represented between the progenitor of *Kutorgina* and *Billingsella*. The process is unknown in *Kutorgina*, but is very clearly developed in the Middle Cambrian forms of *Billingsella* (Pl. LXXXV, figs. 1u–y; Pl. LXXXVI, figs. 3l and 3n; and Pl. LXXXVIII, figs. 1f and 1i). I have not observed it in *Nisusia* or *Nisusia* (*Jamesella*) of the Lower and Middle Cambrian. It appears in *Eoorthis remnicha* (Pl. XCI, figs. 1q and 1r; Pl. XCII, fig. 2b) of the Middle Cambrian, but I have not seen it distinctly in the Ordovician *Protorthis* (Pl. XCIX).

The development of the process followed the definite cardinal area and hinge teeth and must at first have been quite rudimentary. Its absence in *Nisusia* and its presence in *Billingsella* indicate that the latter is a more progressive type in this respect. In the Middle Ordovician orthoid *Dinorthis subquadrata* the cardinal process is striated and fluted so as to give a better holding surface for the attachment of the muscles. In the Silurian genera *Waldheimia* and *Cliothyris* the entire concave part of the area of the dorsal valve projects as a plate posteriorly beyond the beak.

The cardinal process becomes more specialized in its bifurcated condition in the Strophomenidæ and Productidæ, etc. (See Hall and Clarke [1892a, p. 168] for further description of this process.)

ARTICULATING PROCESSES.

Among the Atremata, *Bicia* of the Lower Cambrian shows strong projections on the anterior portion of the cardinal area of the ventral valve beside the delthyrium (Pl. L, figs. 1i–k and 2a), but no corresponding sockets or means of articulation in the dorsal valve. It is a matter of interest to note that bosses occur on both valves (Pl. L, figs. 2, 2a–e) close to the front margin of the cardinal area, which were evidently of service in connection with the movement of the valves. In *Dicellomus* the area of the dorsal valve is sometimes grooved in such a manner (Pl. LII, fig. 1i) as to suggest an articulation with a projection on the ventral valve, and the crenulated margin of figure 1j is suggestive of another tendency toward developing articulation of the valves.

The actual presence or absence of articulating processes in *Kutorgina cingulata* (Pl. V) is very difficult to demonstrate by observation, owing to the character of the matrix in which the specimens occur. That some form of articulating processes is present, however, is indicated by the facts (1) that in a relatively small collection thirty of the valves are united, and (2) that in only a few instances is the dorsal valve in any other than the normal position in which it would have been held by teeth in the ventral valve. In only a few of the specimens have the valves slid or turned either way, as they usually do in the inarticulates.

In the Neotremata, the Lower Cambrian *Obolella* (Pl. LV, figs. 1e–g) has projections suggesting an articulating process on either side of the delthyrium. The same is true of *Trematobolus* (Pls. LXXXIII and LXXXIV).

In the Protremata the articulating processes are well developed in *Billingsella* (Pl. LXXXV, figs. 1n, 1v, and 1w), and, so far as known, in *Nisusia* and the other genera of the order.

SPONDYLIUM.

I am inclined to agree with Doctor Schuchert that the spondylium originated as the result of deposition, within the ventral rostral cavity, of testaceous matter about the bases of the adductor, diductor, and pedicle muscles [Schuchert, 1897, pp. 100–102]. With this conception in mind we may consider that the slightly demarked rostral muscular area of *Nisusia* is one of the earliest known traces of pseudospondylia, and that it is followed by the more decidedly elevated muscular area or pseudospondylium of *Billingsella*, which is of the same type as that of *Clitambonites* and essentially of the same general type as that of *Eoorthis*. In *Filkelnburgia* the pseudospondylium appears to have been supported at its anterior margin by three septa (Pl. XCIII, fig. 2), thus forming a link between the pseudospondylium of *Billingsella* and the spondylium of *Syntrophia*. In *Huenella* (Pl. CIII, figs. 1h, 1i, 2l, and 2m) the spondylium is free at the sides and without a supporting septum (as in *Syntrophia*, Pl. CII, fig. 6g; Pl. CIII, figs. 4d and 4e) or septa (as in *Clarkella*, Pl. CIV, figs. 2c and 2d).

Protorthis has no well-observed cardinal process in the dorsal valve, although it has gained a true spondylium in the ventral; and *Syntrophia* gains a cruralium in the dorsal valve, both valves of *Syntrophia rotundata* having either a spondylium or cruralium supported on a median septum (Pl. CIII, figs. 4d and 4e). In *Clarkella* the spondylium is supported by three or more septa (Pl. CIV, figs. 2c and 2d).

In chronologic order the pseudospondylium of the ventral valve first appears in the Lower Cambrian *Billingsella highlandensis* (Pl. LXXXVII, fig. 4b) and *B. orientalis* (Pl. LXXXVI, fig. 2). It is present in all species of *Billingsella* from the Middle and Upper Cambrian, and has the same form in the Middle Cambrian as in species of *Eoorthis* of the Middle and Upper Cambrian. On this line of descent the pseudospondylium appears in *Orthis* (see Hall and Clarke [1892c, pp. 186–194]) of the Ordovician and later faunas, probably as a reversion from a free spondylium. On the line of descent to *Protorthis* the pseudospondylium becomes a free spondylium and continues on through *Syntrophia* and *Clarkella* into the Ordovician and Silurian Pentameridæ and Clitambonitidæ.

It is not improbable that all Cambrian and Lower Ordovician Protremata have a pseudospondylium or spondylium. In the Orthidæ a pseudospondylium is often suggested, but the

dental plates do not appear to join to form an attached (pseudo) or free spondylium. The points of attachment of the adductor (central) muscle scars appear to have been directly on the surface of the valve and not on a raised platform or pseudospondylium.

At my request, and with all the illustrations of this monograph for study, E. O. Ulrich, who has been studying the Ordovician Protremata, prepared the following notes on the spondylia of the Cambrian and Ordovician Protremata:

Spondylium. This structure, if we regard the term spondylium as referring only to the typical free or medially supported umbonal camera or spoon, is of more common occurrence among articulate brachiopods than is usually believed. Hall and Clarke [1892a, pp. 328–335] discuss the theoretic relations of the spondylium to the deltidium and suggest an expansion of the former term that seems to me to be disproved by the chronogenesis of the articulate brachiopods.

The typical spondylium is more or less rhomboidal in outline and corresponds to a ventral muscular area which is raised above the floor of the valve and formed by the convergence and union of the dental plates. To the concave surface of this structure the ends of the adductor, diductor, and pedicle muscles are attached.

The manner in which the spondylium is attached to the bottom of the valve is so variable that the feature does not seem to be of more than generic consequence. It is free in *Protorthis* and in a related new Ordovician genus; supported by one or three septa in *Clitambonites*, *Pentamerus*, *Syntrophia* (s. s.), *Clarkella*, etc.; partly sessile but anteriorly supported by one or three septa in *Finkelnburgia;* and wholly sessile (resting entirely on the bottom of the valve) in *Otusia* and *Orusia*, *Eoorthis*, *Billingsella*, *Huenella*, and certain Clitambonitidæ, Syntrophiidæ, and Pentameridæ. The muscular area of the ventral valve of the Cambrian *Orthis*-like brachiopods never agrees perfectly with that of any of the described Ordovician Orthidæ. In the latter the dental plates of the ventral valve never meet and the area is more or less distinctly bilobed and very rarely elevated, though it may be so depressed in thick shells as to suggest a spondylium. In the Cambrian types in question the muscular area is often elevated, commonly suggests and frequently forms a true spondylium, and as a rule is more or less distinctly rhomboidal in outline. These features, together with the arrangement and components of the muscle scars of the dorsal valve, suggest a relationship with the Ordovician Clitambonitidæ rather than with the true Orthidæ.[a]

Of the true Ordovician orthids, it seems to me that the groups represented by *O. callactis-tricenaria* and *Dalmanella* (especially the *D. subæquata* section) are the oldest and most persistent. Both of these types often retain unresorbed remnants of the deltidium, and in the development of their dental plates and septa and in the shape and arrangement of their ventral muscular areas they agree with the average Cambrian articulate more closely than do any other Ordovician or Silurian orthoids, with the possible exception of *Plectorthis*. Thus, except in the matter of surface plication, the resemblance between *Orthis tricenaria* and *Billingsella romingeri* (Barrande) is rather striking. But it is to be noted that the muscular area in the ventral valve of *O. tricenaria* (as in *Dalmanella subæquata*) is blunt and gently bilobed or obscurely trilobed anteriorly, and not subrhomboidal in outline. *Plectorthis whitfieldi* has longer and broader ventral adductor scars than any other Ordovician or Silurian orthoid known to me, and on this account its muscular area resembles that of *Billingsella* more closely. *Plectorthis whitfieldi* is, however, of late Ordovician or Silurian age and lived at a time of very rapid evolution (and possibly reversion) among brachiopods, when other orthoids of the same type (*Orthis* (*Billingsella*) *laurentina* (Billings) and *Orthis flabellites*) were reverting to ancestral characters; or it may be that they were immigrants from some other area where the older characters persisted.

This difference in shape of the ventral muscular area in the Billingsellidæ and Orthidæ is due to the fact that in the former the median (adductor) scars are always longer and as wide or wider than the lateral (diductor) pair. In the Orthidæ the adductor scars are of the same general shape as the corresponding scars in the Billingsellidæ, but are relatively smaller and shorter. They are as long as the diductors in *Orthis tricenaria*, *Plectorthis whitfieldi*, and *Dalmanella subæquata*, and in others [*Dinorthis*, *Rhipidomella*, etc.] they are much shorter and more or less completely inclosed anteriorly by the revolutionary tendency of the area of the diductors to expand at the expense of the adductors.

A natural division of the orthoids into two families may thus be established:

(1) Ventral muscular area small, obovate or obcordate; adductors reaching front margin of area (*Orthis* (s. s.), *Plectorthis*, *Platystrophia*, *Hebertella*, *Orthostrophia*, *Dalmanella*).

(2) Ventral muscular area large, bilobed or elliptical; adductors proportionately small and more or less completely inclosed anteriorly by the flabellate diductors [*Heterorthis*, *Plæsiomys? deflecta* group, *Dinorthis*, *Bilobites*, *Rhipidomella*, *Schizophoria*, *Orthotichia*].

Another well-marked difference between the true Ordovician orthoids and their billingsellid ancestors is in the arrangement of the muscle scars of the dorsal valve. In the Billingsellidæ they are somewhat elongate and more or less radially arranged (Pl. LXXXVIII, figs. 1f–k; Pl. XCIII, fig. 1f; and Pl. XCIX, fig. 2d) and in the Orthidæ [*Orthis tricenaria*, *Plectorthis*, *Dalmanella*, and *Orthis tritonia*] they are shorter and placed longitudinally. Some of the later orthoid forms in the second group [*Bilobites*, *Rhipidomella*, and *Schizophoria*] are characterized by a radial arrangement of the dorsal muscle scars, but the ventral muscular areas are here highly developed and bear little resemblance to those of the Billingsellidæ.

[a] Commenting on this, Dr. Charles Schuchert wrote me: "This is a very important point. It has often struck me that all the early Cambrian brachiopods have an incipient spondylium, sometimes free, sometimes supported, or sessile. Out of the sessile forms have developed the true orthids."

CRURALIUM.

In the dorsal valve an immature cruralium is seen for the first time in *Nisusia festinata* (Pl. C, fig. 1g at d, and fig. 1j at cr) which is without a cardinal process; this appears to be the first appearance in the Lower Cambrian of a muscle-supporting projection in the dorsal valve of an articulate brachiopod. In *Billingsella* a cardinal process is developed (Pl. LXXXV, figs. 1u and 1v) on a low crural thickening. This process is present in *Eoorthis* and *Orthis* and is prominent in *Dinorthis, Hebertella,* and most of the Orthidæ, Strophomenidæ, and Productidæ.

A well-developed cruralium in the dorsal valve is first seen in *Syntrophia* (*S. rotundata,* Pl. CIII, fig. 4e) of the Upper Cambrian. It is well developed in *Clarkella, Conchidium,* and other genera of the Pentameracea.

PLATFORM.

Hall and Clarke [1892c, p. 46][a] state that—

> The specialized postmedian testaceous deposit which has been termed the platform by Messrs. Davidson and King occurs among Brachiopoda only in the genera *Lakhmina* [=*Neobolus*], *Lingulops, Lingulasma, Dinobolus, Trimerella, Monomerella,* and *Rhinobolus;* it constitutes the principal diagnostic character of the family Trimerellidæ of those authors, and in so far as any of these genera possesses this feature, so far, at least, it is a trimerellid. In its chronogenesis it is accompanied by certain peculiar phenomena. According to our present knowledge, its first appearance is in the little *Lakhmina* [=*Neobolus*] from the primordial "*Obolus* beds" in the Salt Range of India; but in American faunas, where the development of the group is best exemplified, it is first met in *Dinobolus* (in external features the most oboloid form of the group) in the later faunas of the Lower Silurian: Black River, Trenton, Galena. Thereupon follow in the still later fauna of the Hudson group the more pronounced linguloid genera, *Lingulops* and *Lingulasma.* Not, however, until the introduction of the Niagara or Wenlock fauna does the entire group, with the exclusion of the inceptive linguloid forms, reach its culmination in specific and individual development. * * * With the disappearance of this fauna the platform-bearing brachiopods virtually became extinct, and we have as yet no trace whatever of the occurrence of this peculiar feature at any later date or in any other group of these animals.

These authors conclude that it is probable—

> that the inception of the platform is due to the slight variation indicated in the mode or rate of formation of the muscular fulcra in *Lingula,* and this may itself have been due in part to a simple increase in the size of the muscular bands.

In summing up their conclusions on the source and development of the platform in the trimerellids, the statement is made that "we are confronted with the interesting phenomena of a similar resultant attained along different lines of development." This is expressed in a diagram in which *Obolella* and *Lingulella* are taken as the first stages of two lines of development. On the line of *Obolella* come in succession *Obolus, Elkania, Dinobolus,* and *Trimerella.* On the line of *Lingulella* come in succession *Lingula, Lingulops, Lingulasma, Trimerella,* and, as an offshoot from *Lingulasma, Monomerella* and *Rhinobolus. Lakhmina* [=*Neobolus*] is placed in a central line between *Obolus* and *Lingulella* [Hall and Clarke, 1892c, p. 52]. For the full discussion of the views of Hall and Clarke the student should consult the original work [Hall and Clarke, 1892c, pp. 46–55].

In the course of my studies of the Cambrian brachiopods I came to the conclusion that the platforms so far as developed were the result of shell secretion beneath and about the points of attachment of the muscles, also beneath the visceral cavity. In the dorsal valve of *Rustella* (Pl. I, fig. 1e) from the Lower Cambrian, the most primitive type of brachiopod known to me, the central and anterolateral muscle scars are slightly raised above the general level of the interior of the valve; many natural casts of the interior of the ventral valve fail to show traces of the points of attachment of the muscles.

I have assumed that *Obolus* was divergent from the same stock or radicle as *Rustella,* and that *Lingulella* is an early divergent from *Obolus.* (See schematic diagram, p. 317.) None of the Lower Cambrian species of *Obolus* or *Lingulella* known to me has any unusual thickening of the valves over the visceral area or about the muscle scars, but in the Middle and Upper Cambrian it is not uncommon to find more or less indication of it. *Obolus mickwitzi* (Pl. X, figs. 1, 1a–k) of the Middle Cambrian is a striking example, and *Obolus apollinis* (Pl. VII) of

[a] Observations on the development and function of the platform in the inarticulate Brachiopoda.

the Upper Cambrian affords fine illustrations of the general thickening of the shell beneath the visceral area in both valves, while the points of attachment of the muscles may be depressed (Pl. VII, figs. 10 and 17) or elevated (Pl. VII, figs. 9 and 14). The thickening of the shell is also well shown by the ventral valves of *Obolus* (*Schmidtia*) (Pl. XIV, figs. 1a, 3a, and 4a) and less well by the dorsal valves (Pl. XIV, figs. 1c, 4c, and 4d). *Obolus cyane* (Pl. XXVII, fig. 4b) from the Lower Ordovician has an unusually well-developed thickening beneath the visceral area of the dorsal valve. Many other illustrations might be given from *Obolus* and its subgenera.

In *Lingulella* and its subgenera there is a striking development of the primitive or early stages of the platforms, and they are present in many species—*L. acutangula* (Pl. XVII) and *L. granvillensis* (Pl. XXII, figs. 1b and 1d) of the Lower Cambrian and *L. dubia* (Pl. XXIV, figs. 4 and 4a) and *L. ino* (Pl. XXVI, fig. 4) of the Middle Cambrian. Of Upper Cambrian species only the small *L. ferruginea* shows a slight thickening of the valves beneath the visceral area (Pl. XXIX, figs. 1r and 1s).

From *Lingulella* there appears to have been an offshoot in Middle Cambrian time in *Obolus* (*Fordinia*) *perfectus* (Pl. LXIII, figs. 10, 10a–d) that developed a strong tendency toward the formation of a rudimentary posterior thickening in the interior of the valves. Two species, *Obolus* (*Fordinia*) *bellulus* (Pl. LI, figs. 3, 3a–f) and *O.* (*F.*) *gilberti* (Pl. LI, figs. 5, 5a–d) from the Upper Cambrian, also show the same tendency. The rudimentary platform of *O.* (*Fordinia*) *perfectus* (Pl. LXIII, figs. 10a and 10c) is intermediate in development between those of *Obolus apollinis* (Pl. VII) and *Elkania desiderata* (Pl. LI). The position of the central group of muscle scars, at the anterior sloping ends of elevated ridges, marking the path of advance of the scars with the growth of the shell, is beautifully shown in figure 10a of the ventral valve of *O.* (*F.*) *perfectus* (Pl. LXIII). In the dorsal valve of the latter species there is marked thickening of the shell beneath the visceral area, and a marked median septum or ridge just in front of the cardinal area (Pl. LXIII, fig. 10c) is very suggestive of a cardinal process. The ventral valve of *Elkania desiderata* (Pl. LI, fig. 1) has a strong, solid, rudimentary platform into which the interior cardinal area is blended, and the position of the central group of muscle scars is on the front slope of the platform; in the dorsal valve (Pl. LI, figs. 1c and 1d) a rudimentary platform is also clearly indicated. The dorsal valve of *Elkania ambigua* (Pl. LI, fig. 2c) may have a fairly strong rudimentary platform or be without it (Pl. LI, fig. 2b). *Elkania ida* (Pl. LI, figs. 4b and 4c) has the rudimentary platform finely developed in both valves.

Lingulasma schucherti [Hall and Clarke, 1892c, Pl. II, figs. 17–23] of the Upper Ordovician appears to be the best expression of an intermediate form between *Obolus* (*Fordinia*) (Pl. LXIII, figs. 10, 10a–d) and the forms represented by *Dinobolus* [Hall and Clarke, 1892c, Pl. IVB] and *Trimerella* [Hall and Clarke, 1892c, Pl. IVA] of the Silurian, but it is quite probable that *Lingulasma* was not in any way intermediate between *Fordinia* and the trimerellids. It seems to represent a side branch of *Lingula*.

The line of development of the platform to Ordovician and Silurian forms seems to have been from some *Obolus*-like form, as *Fordinia* to *Neobolus* (Pl. LXXXI, figs. 2e and 2f), and thence to *Dinobolus*. I thought at one time that *Elkania* might be a possible ancestral line to the Trimerellidæ, but, after carefully considering the position of the rudimentary platforms, I concluded with Schuchert that *Elkania* was an offshoot from *Obolus* that did not leave any known descendants.

SEPTA.

The septum of the dorsal valve of the Obolidæ is usually in the form of a narrow ridge, and is not a true septum in the usual sense, which is that a septum is a thin median vertical plate of variable height, terminating freely or supporting a spondylium. Well-developed septa occur in the Syntrophiidæ as supports beneath the spondylia (Pl. CIII, figs. 3d and 3e; Pl. CIV, figs. 2c and 2d).

DENTAL PLATES.

Dental plates first appear, so far as known, in the Protremata as obscure processes supporting the teeth of the ventral valve, one on each side of the delthyrium. One of the oldest examples

is that of the Lower Cambrian *Nisusia festinata* (Pl. C, fig. 1j), where the plates form the support of the teeth and also outline a rudimentary spondylium. *Protorthis* of the Middle Cambrian has a spondylium on each side of which are the teeth supported at each of the outer angles next to the cardinal area (Pl. XCIX, fig. 3b). Dental plates undoubtedly existed in other genera of the Protremata of the Cambrian, but they have not been observed.

VASCULAR MARKINGS.

The most prominent of the vascular impressions are the pallial sinuses or main vascular canals. Usually all that is impressed on the inner surface of the valves are the two main trunks that diverge from near the apex or beak of the valves and skirt the margin of the visceral area. In rare instances the impressions of the secondary branches of the main sinuses are preserved.

ATREMATA.

None of the shells of the genera of the Paterinidæ show more than the bases of the main trunks of the vascular system, but in *Obolus* and *Lingulella* and their subgenera there are numerous illustrations of the main vascular canals and in a few instances of the secondary canals.

Obolus apollinis (Pl. VII) of the Upper Cambrian has the vascular system as well developed, judging from the impressions left by it on the interior of the valves, as in the mantle of recent *Lingula*. In the closely allied form, *Lingulella granvillensis* (Pl. XXII, figs. 1b and 1d), from the Lower Cambrian, there is every reason to think that the vascular system has reached its full development. The main vascular trunks, lateral canals, and peripheral canals are all indicated in the ventral valve (Pl. XXII, fig. 1d). Striking illustrations of the preservation of the markings of the vascular system are shown in many of the illustrations. (See Pl. VIII, fig. 1d; Pl. XII, figs. 1c, 1e, 9, and 9a; Pl. XIII, fig. 1m; Pl. XV, fig. 1l; Pl. XVII, figs. 1h and 1j; Pl. XXXVI, figs. 1c and 1d; Pl. XXXVII, fig. 1c; and Pl. XXXVIII, figs. 2b and 2d.)

In *Bicia* (Pl. L), one of the oldest of the Obolidæ, the main vascular trunks are very strong, and they are prominent in *Dicellomus* (Pl. LII, figs. 1d and 1j; Pl. LIII, figs. 1d, 2, and 4a).

NEOTREMATA.

In the Neotremata, *Obolella*, the most primitive form, has the vascular trunks developed (Pl. LIV, figs. 2g–n) on a scale comparable with those of *Obolus*, but, as is usually the case among Cambrian brachiopods, the calcareous shells do not appear to bear the impressions of the secondary canals as well as do the chitinous or phosphatic shells. The main vascular canals of *Botsfordia* (Pl. LVII, figs. 4g–m; Pl. LIX), *Linnarssonella* (Pl. LXXIX, figs. 1m–p, 2, and 2a), *Trematobolus* (Pl. LXXXIII), *Yorkia* (Pl. LXXXII, figs. 1h and 2), *Schizambon* (Pl. LXXXIV, figs. 1a, 1c, 2d, 3b, and 3c), and *Dearbornia* (Pl. LXXXII, figs. 7b and 7c) are all strongly developed. In *Acrothele* are found some of the most beautiful examples of the preservation of a highly developed system of vascular canals (Pl. LVI, figs. 1a–d, 3b, and 3c; Pl. LXI, figs. 1c and 1d). *Acrotreta* has relatively large vascular trunks (Pl. LXIV, figs. 1i, 1j, and 2c; Pl. LXV, figs. 1f, 1g, 3c, and 6; Pl. LXXIII, figs. 4c and 6), but no traces have been seen of the lateral canals. The main trunks of *Acrothyra* are also large (Pl. LXXVI, figs. 4a and 4b). *Discinopsis* (Pl. LXXXII, figs. 5a–b) has two narrow, long, main trunks that originate back of the line of the opening of the pedicle tube.

PROTREMATA.

In *Billingsella* the great size of the main vascular trunks (Pls. LXXXV–XC) is characteristic of the genus. The manner in which the anterior branches of the main trunks pass outward toward the border is finely shown in specimens of *B. plicatella* (Pl. LXXXVI, fig. 3i). The dorsal valve of *B. exporrecta* (Pl. LXXXVIII, fig. 1k) has two strong apparently main sinuses on each side; the inner pair, however, may not be casts of the vascular sinuses, but may indicate grooves made by the path of advance of the attachments of the posterior adductor muscles.

The vascular system of *Nisusia* (Pl. C) and its subgenus *Jamesella* (Pl. CI), *Protorthis* (Pl. XCIX), and usually of *Eoorthis*, has left no traces of its presence on the shell. On some

examples of *Finkelnburgia* (Pl. XCIII, figs. 1d, 1f, 2, and 2b) there are indications of large main trunks, and in *Orusia* (Pl. XCVIII, figs. 1e and 1p) narrow trunks are seen. Only one among many hundreds of specimens of *Eoorthis* (Pl. XCI, fig. 3b) shows traces of the main trunks.

Among the Syntrophiidæ, *Huenella abnormis* (Pl. CIII, figs. 2b and 2h) shows that the main trunks were of large size. I have not seen any interiors of the shells of the Strophomenidæ from the Cambrian system.

This brief review proves that the simple primitive type of the circulatory system, as developed in the main vascular canals, their laterals, and the peripheral canals of the mantle, was fully developed in Lower Cambrian time, and that this type persisted throughout Cambrian time. The modified form of the canal system of the Craniidæ has not been observed, nor has the complex canal system of the Ordovician and later orthoids [Hall and Clarke, 1892c, Pls. Va, Vc, VI, and VIa].

MUSCLE SCARS.

It is only within a few years that material has been available from Cambrian rocks that could furnish data for a description of the muscle scars and by them an outline of the muscular system of the Cambrian brachiopods.

ATREMATA.

In the Atremata this has been most thoroughly worked out for *Obolus* by Mickwitz (1896), and an outline may be found in this monograph under the description of the genus *Obolus*. The terminology used in this monograph is mentioned on page 292.

In the most primitive form of brachiopod known to me, *Rustella edsoni*, the muscle scars of the dorsal valve, so far as known, indicate that the system of scars was essentially the same as in *Obolus*. In the dorsal valve the central scars (Pl. I, fig. 1e) are preserved; also the anterior portion of the outline of the parietal band, which indicates the position of the anterolateral scars. Although we have a number of good natural casts of the interior of the ventral valve, no traces of vascular markings or muscle scars have been observed. So far as known none of the many hundreds of specimens of various species of *Micromitra* have preserved any definite outlines of the muscle scars, and the same is true of *Mickwitzia* and *Helmersenia*.

Obolus and *Lingulella* and their subgenera all have the same general grouping of the muscle scars as described under *Obolus*. For *Obolus* these are well shown in *O. apollinis* (Pl. VII); for *Lingulella* by *L. acutangula* (Pl. XVII); for the subgenus *Westonia* by *Obolus* (*Westonia*) *escasoni* (Pl. XLIX, figs. 1a, 1aa, 1c, and 1d). The same general arrangement of the muscle scars, so far as known, is found in *Bicia* (Pl. L), *Elkania* (Pl. LI), and *Obolus* (*Fordinia*) (Pl. LXIII, figs. 10a and 10c). In *Dicellomus* the central and the outside and middle lateral scars are located in front of the visceral area, as in *Obolus*, but the anterolateral and transmedian scars are combined in one large cardinal scar (Pl. LIII, fig. 1c at cl), as in *Acrotreta* (Pl. LXIV, figs. 2c and 2d); in the dorsal valve the central and anterolateral scars are as in *Obolus*, while the transmedian, outside laterals, and middle laterals appear to be grouped in one large cardinal scar (Pl. LIII, fig. 1i at cl). The combining of the muscle scars of the posterolateral region of the valves in one large scar in this genus of the Atremata foreshadows the typical large cardinal scar so characteristic of the Neotremata.

NEOTREMATA.

In *Obolella* (Pls. LIV and LV) the arrangement of the muscle scars, so far as known, is that of *Obolus*, but with a tendency on the part of the posterolateral scars to close in toward each other; this tendency is carried into effect in *Botsfordia* (Pl. LIX, figs. 1k and 1n; Pl. LVII, fig. 4k; and Pl. LXII, figs. 5g and 5i). In the dorsal valve of *Botsfordia pulchra* (Pl. LXII, fig. 5h) the transmedian and middle lateral scars appear to be distinct, but in figure 5i and in all ventral valves, figures 5g and 5j, a single large scar appears to be present. In *Linnarssonella*, which I have placed as the descendant from the *Acrotreta* stock (schematic diagram, p. 317), the posterolateral scars are all grouped in both valves in a large cardinal muscle scar (Pl. LXXIX, figs. 1k–p). The muscle scars of the central portion of the valves remain essentially as in *Obolus*.

The system of muscle scars in *Trematobolus* (Pl. LXXXIII) is, so far as known, that of *Obolus*, with a modification probably of the position of the scars of the pedicle muscles; of the latter, unfortunately, nothing is known. *Dearbornia* (Pl. LXXXII, figs. 7b and 7c) has the same arrangement of the muscle scars as *Trematobolus*, but of the muscle scars of the other genera descendant from the *Trematobolus* stock we know very little. The interiors of *Siphonotreta* (Pl. LXXXI, figs. 6c, 6d, and 6e) indicate an arrangement somewhat like that of *Trematobolus*. *Yorkia*, *Orbiculoidea* as known in the Cambrian, and *Philhedra* show nothing of the muscle scars. *Schizambon* (Pl. LXXXIV) appears to be related in its muscle scars to *Trematobolus*.

The muscle scars of *Acrothele*, *Acrotreta*, and *Acrothyra* agree in having the posterolateral scars united on each side in one large cardinal scar situated in the posterolateral region of the valves. The central and anterolateral scars of the dorsal valve are variously situated (Pl. LVIII, figs. 5f and 5h, and Pl. LX, fig. 1l) in the central portion of the interior of the valve, but not more so than in the dorsal valve of *Obolus*. In the ventral valve the outside and middle laterals and the central scars are more or less contracted, and drawn back toward the small visceral area about the pedicle opening; the individual scars have not been seen except in one specimen of *Acrotreta argenta* (Pl. LXVII, fig. 5b). In this species the visceral area is unusually large and the positions of the outside lateral and central scars is shown; the anterolaterals are not delimited. Another species of *Acrotreta*, *A. ophirensis* (Pl. LXXIV, fig. 1e), has an unusually large visceral area, but, although the area of the muscle scars is defined, the individual scars can not be seen. No reference has been made to the umbonal muscle scars, as they are so rarely preserved. They are well developed and shown in *Obolus* and *Lingulella*, and it is highly probable if not certain that some form of umbonal muscle existed in all of the inarticulate brachiopods.

PROTREMATA.

The muscles of the Protremata are limited to three sets: diductors, to open the valves; adductors (centrals), to close the valves; and the pedicle muscles.

In *Kutorgina*, the atrematous progenitor type of the Protremata, the anterior and posterior adductors (equal to the anterolateral and central scars, respectively) are known in the dorsal valve (Pl. V, fig. 1h), but nothing is known of the point of attachment of the diductor muscles in the dorsal valve or of any muscles in the ventral valve. The muscle scars are preserved in *Billingsella* in the ventral valve within the area of the pseudospondylium. The diductors probably occupied the outer divisions of the tripartite pseudospondylium and the adductors the central section. This is well shown in many specimens (Pl. LXXXV, figs. 1m and 1p; Pl. LXXXVI, figs. 3g, 3i, 3j, 3k, 3m, and 4b; Pl. LXXXVII, figs. 5b, 5c, and 7; and Pl. XC, figs. 2g, 2h, and 2i). The diductors appear to have followed closely in the line of the scars of the main vascular sinuses if the tripartite pseudodeltidium is considered to have been wholly taken up by the points of attachment of the muscles. In the dorsal valve the adductor scars are often prominent (Pl. LXXXVIII, figs. 1g, 1h, 1j, and 1k), also the cardinal process to which the diductor muscles were attached. The interiors of the ventral valves have not thus far shown muscle scars.

The muscle scars of the ventral valve of *Nisusia* and its subgenus *Jamesella*, and those of *Finkelnburgia*, *Orusia*, and *Protorthis*, were probably gathered on a pseudospondylium or, when the latter is not defined, on the bottom of the valve beneath the umbo, as in *Eoorthis*. In an obscure specimen of the dorsal valve of *Portorthis quacoensis* (Pl. XCIX, fig. 2d) the posterior adductor scars appear to be preserved.

In the dorsal valve of *Finkelnburgia* the adductors are finely shown (Pl. XCIII, fig. 1f), also a rounded, posterior central depression in which the diductors may have been attached.

Among the Cambrian Syntrophiidæ muscle scars have been discovered in *Huenella abnormis* of the Upper Cambrian. In the ventral valve (Pl. CIII, fig. 2b) the adductor and diductor scars are preserved on the spondylium, and dorsal valves (Pl. CIII, figs. 2f, 2i, and 2j) show the adductors in fine preservation, also the cruralium to which the diductor muscles were attached. The muscle scars of this species are of unusual interest, as the ventral valve has a spondylium to which the pedicle, the large diductor, and the smaller scars of the adductor muscles were attached.

PEDICLE TUBE AND APERTURE.

ATREMATA.

When the pedicle rests in furrows on the areas of the valves, as in *Obolus* (Pls. VII and XIV), it pertains to both valves, but with the deposition of a narrow band of shell about it on the ventral valve it strictly pertains to this valve alone, although it may still rest against the area of the dorsal valve before passing through the semitube of the ventral valve. The transition from the deep but open pedicle furrow of the ventral valve of *Obolus* to the inclosed sheath or tube of *Obolella* is found in *Dicellomus politus*. In this species there has been a deposit of shelly matter that rises up from the sides of the pedicle furrow on the ventral valve and arches slightly inward, almost forming a tube in places; what remains of this semitube is shown by figures 16A and 16B.

NEOTREMATA.

The earliest and simplest stage of development of the pedicle tube when it completely surrounded the pedicle is found in *Obolella* of the Lower Cambrian (Pls. LIV and LV). In this genus the deep pedicle furrow of the ventral valve of *Dicellomus* has been covered over just at the apex of the cardinal area so as to form a simple ring or tube about the pedicle. In the next stage, as shown by *Botsfordia* (Pls. LVII and LIX), the pedicle has advanced its opening to the front side of the apex and the tube between it and the furrow in the area is a little stronger and a trifle larger.

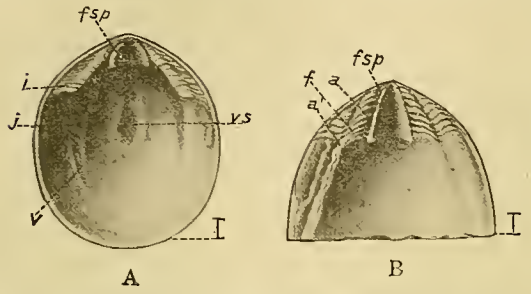

FIGURE 16.—*Dicellomus politus* (Hall). A, Interior of ventral valve (fsp, pseudospondylium or pedicle plate; i, transmedian scars; j, anterolateral scars; v, visceral cavity; vs, main vascular sinuses). B, Posterior portion of the interior of a ventral valve, showing a strongly developed area (fsp, pseudospondylium or pedicle plate; a, inside section of area; f, flexure line; a', outside section of area).

The specimens represented by figures 16A and 16B are from Locality 79s, Upper Cambrian "St. Croix sandstone" at Hudson, Wisconsin (U. S. Nat. Mus. Cat. Nos. 51917a and 51917b, respectively). The same figures are reproduced on page 576.

In *Linnarssonella* (Pls. LXXVIII and LXXIX) the opening of the pedicle tube is close to the posterior margin and the *Obolella*-like structure in both valves is very striking. This is best seen by comparing the casts of the interior of the ventral valves of *Linnarssonella* (Pl. LXXIX, figs. 3c–g) with those of *Obolella atlantica* (Pl. LV, figs. 1f–h). In both species the cast of the pedicle tube is in the same position in relation to other parts, and the external opening of the pedicle tube is at the apex above a low false cardinal area.

The depressed forms of *Acrothele*, with the apex near the posterior margin, appear to have been descendant from the *Obolella* stock but to have reached a stage of development more advanced than any known form of the Cambrian genus *Obolella*. *Acrothele bellula* (Pl. LVIII, figs. 5, 5a–h) of the Middle Cambrian appears to be one of the oldest forms and to have retained in its ventral valve characteristics of its obolelloid ancestors. In the ventral valve the pedicle tube penetrates the thickened apex of the shell and there is considerable space between the pedicle aperture and the posterior margin; the tube and aperture are essentially the same in all the species of *Acrothele*, differing only in details due to a rather narrow range of position and the varying thickness of the shell. The genus *Schizopholis* (Pl. LXXXI, figs. 1, 1a–c) has a more nearly vertical posterior slope and distinctly marked false area, in this respect resembling the large group of species referred to *Acrotreta*. The pedicle tube and aperture of the latter are of the same type as in *Acrothele*, differing only in form and position within a narrow range. *Acrothyra* also shows little variations. *Discinolepis* (Pl. LXXXI, figs. 3 and 3a) has the pedicle opening more advanced and appears to be a form intermediate between *Acrothele* and *Acrotreta*.

The pedicle tube of *Keyserlingia* (Pl. LXXXI, fig. 4c) apparently opens into an elongated depression in the shell back of the apex of the ventral valve; the tube is a passage through a thickened mass of shell which is deposited about the pedicle and which is especially well developed in old shells (Pl. LXXXI, figs. 4a and 4d).

PROTREMATA.

A pedicle tube or opening is found in the genus *Billingsella* of the Lower Cambrian, the characteristic opening being at the apex of the delthyrium (fig. 65, p. 750). It has not been observed in *Nisusia* (Pl. C) nor in the subgenus *Jamesella* (Pl. CI), nor in any other genus or subgenus of the Protremata of the Cambrian fauna. This may be owing to the absence of a deltidium in the adult stages of the shell found, to its being covered by the incurved beak, to the difficulty of working out or uncovering the deltidium so that it can be seen, or in all probability to the permineralization of the shell and the generally coarse nature of the sediments deposited with the shells. It may be that the opening was closed naturally in the adult stages as in some of the Ordovician *Clitambonites*. Even in *Billingsella*, where the material is abundant and well preserved, it is only rarely that an entire deltidium is obtained and very rarely that the minute pedicle opening can be seen at its apex.

OLD-AGE CHARACTERS.

I have not given special attention to old-age characters during the progress of the study of the Cambrian brachiopods. The variations due to old age during the gerontic period appear in the unusual thickening of the shell of *Obolus apollinis* (Pl. VII), but old age is not indicated on the exterior of the shell (Pl. XIV, figs. 6 and 6a). The areas of attachment of the muscles in *Obolus mickwitzi* (Pl. X) suggest old age, and the strong concentric ridges at the front of the valves is another phase of old-age conditions. *Obolus* (*Lingulobolus*) (Pl. XVI), in its thick shell, large deep muscle scars, and convex valves indicates an old-age form derived from *Obolus*. In *Keyserlingia buchi* (Pl. LXXXI, figs. 4a–e) the interior shell growth associates the species with old-age forms.

There is abundant material for study of many of the species described in this volume that may, when carefully worked up and studied, give some interesting results in relation to changes in the shell during the mature (neologic) and old-age (geratologic) periods of growth.

DISTRIBUTION IN CAMBRIAN STRATA.

We do not know of any brachiopods in strata older than that containing the Mesonacidæ or Lower Cambrian fauna. That such existed in pre-Cambrian time seems almost certain when the advanced stage of development of some of the earliest-known forms is considered.

In the following diagram the known occurrence of the families of brachiopods in strata of Cambrian age is graphically shown. The diagram is based on the data contained in the table (p. 112) giving a summary by families. The Obolidæ, with 6 genera, 9 subgenera, 186 species, and 14 varieties, has the greatest development, and this family continues into the base of the Ordovician with 4 genera, 3 subgenera, 41 species, and 1 variety. The Acrotretidæ has 6 genera, 1 subgenus, 100 species, and 20 varieties, with the greatest development in the Middle Cambrian and with a smaller representation in the Lower Ordovician. The Billingsellidæ, with 9 genera, 2 subgenera, 91 species, and 12 varieties, has a strong line of development from the upper Middle Cambrian and passes into the Ordovician, where it disappears. The three families mentioned include about 48 per cent of the genera, 80 per cent of the subgenera, 80 per cent of the species, and 79 per cent of the varieties included in the Cambrian Brachiopoda. The development of genera of the remaining families containing 3 genera or more is as follows: Paterinidæ, 3; Obolellidæ, 4; Siphonotretidæ, 6; Syntrophiidæ, 3; or 16 genera of the 23 outside

of the Obolidæ, Acrotretidæ, and Billingsellidæ, which contain 21 genera. The remaining 7 families include 7 genera.

Of the 44 genera from the Cambrian, 19 occur in the Lower Cambrian, 31 in the Middle Cambrian, and 20 in the Upper Cambrian.

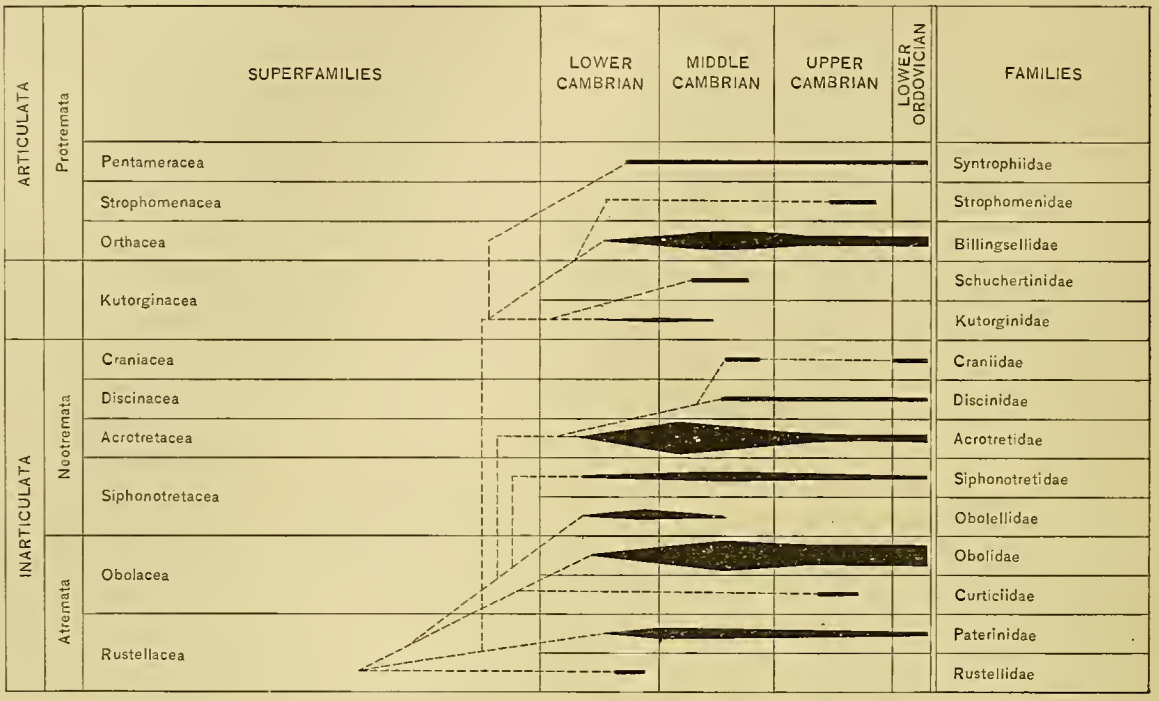

FIGURE 17.—Diagram illustrating known distribution of families in Cambrian strata.

EVOLUTION OF THE CAMBRIAN BRACHIOPODA.

SCHEMATIC DIAGRAM.

In order to formulate, so far as possible, in a graphic manner my conception of the evolution and lines of descent of the Cambrian Brachiopoda, gained by the investigations described in this monograph, a schematic diagram (fig. 18) has been prepared.

This diagram is necessarily tentative and incomplete, but it will serve to point out my present conceptions of the lines of evolution of the various genera, and it shows clearly the very rapid development of the primitive atrematous genera in early Cambrian time.

The genera identified from each of the three divisions of the Cambrian may be ascertained by glancing at the columns headed Lower, Middle, and Upper Cambrian for the generic and subgeneric names included in each column.

The most primitive but not the oldest species known to me from the Cambrian formations is *Rustella edsoni* (Pl. I, figs. 1, 1a–e). This is found in association with *Olenellus thompsoni* in Vermont, where it occurs at nearly the summit of the Lower Cambrian, and not low down toward the base of the Cambrian system. Probably the oldest-known brachiopod, or the species lowest in the stratigraphic series, is *Trematobolus excelsis* (Pl. LXXXII, figs. 8, 8a–d). This is far advanced in development and must have had a long line of descent from the protegulum stage. Another very ancient type is *Micromitra*. A species with ornamented surface (*M. (Iphidella) louise*) occurs 2,850 feet down in the Lower Cambrian of the Canadian Rockies and *Micromitra (Iphidella) pannula* (Pl. IV) is abundant in the upper portion of the Lower Cambrian. *Micromitra (Paterina) labradorica* (Pl. II) is found deep in the Lower Cambrian of New Brunswick

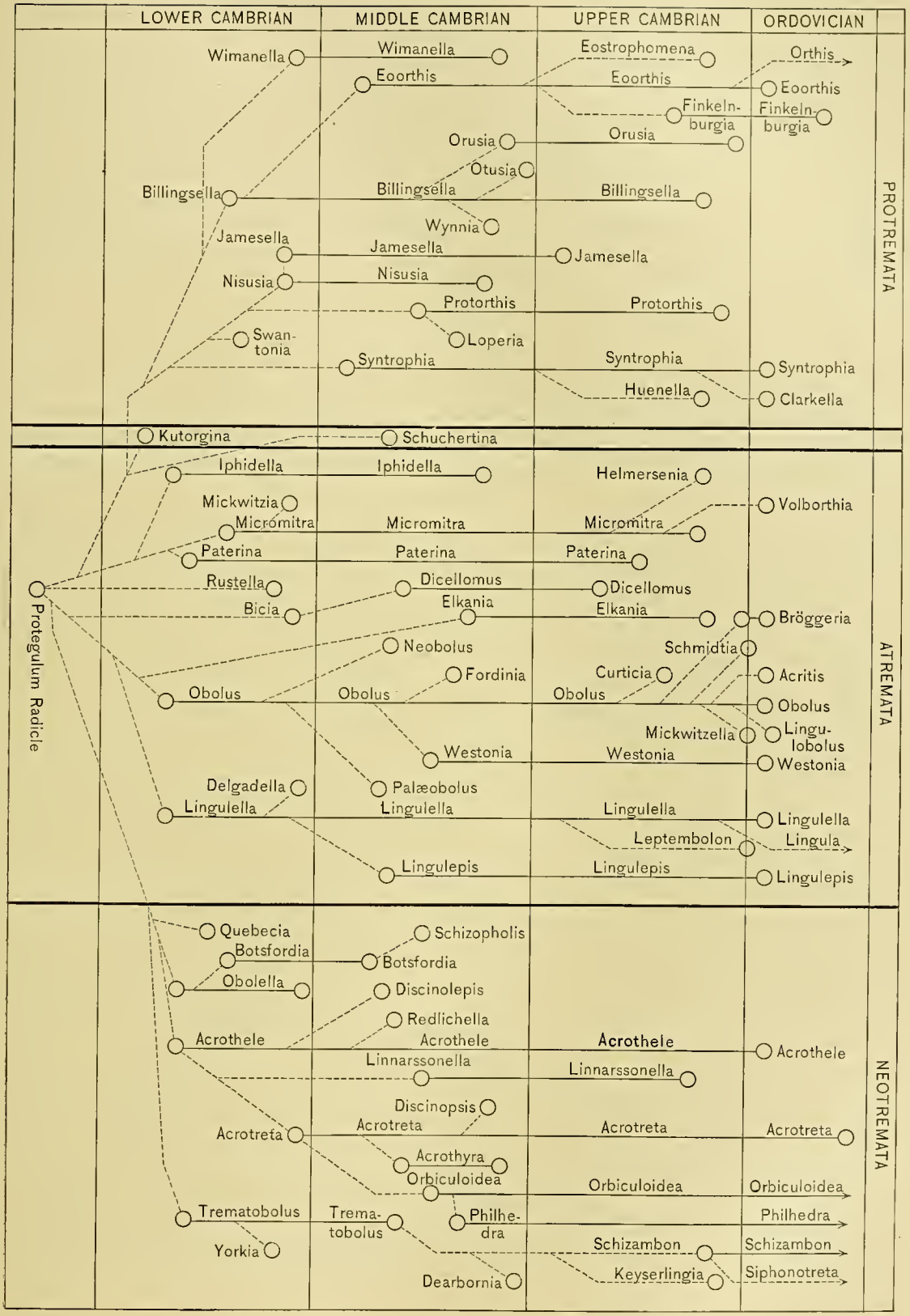

FIGURE 18.—Schematic diagram of evolution of Cambrian Brachiopoda.

and is the oldest brachiopod known from the Atlantic Province. *Bicia* (Pl. L), *Obolella* (Pls. LIV and LV), *Quebecia* (Pl. CIV), *Botsfordia cælata* (Pl. LIX), *Acrothele bellapunctata* (Pl. LVII, figs. 3, 3a–b), *A. decipiens* (Pl. LVIII, figs. 3, 3a–d), *A. woodworthi* (Pl. LX, fig. 6), *Acrotreta emmonsi* (Pl. LXV, fig. 6), *A. primæva* (Pl. LXIX, figs. 1, 1a–f), and *Yorkia* (Pl. LXXXII) occur with other forms in the upper portion of the Lower Cambrian fauna. All of these examples of inarticulates indicate that the brachiopod fauna had advanced far in its evolution in Lower Cambrian time. Among the progenitors of the Protremata, *Kutorgina* (Pl. V) occurs in the Mesonacidæ fauna, and *Schuchertina* (Pl. LI) of the Middle Cambrian probably springs from the *Kutorgina* stock in Lower Cambrian time. Among the articulates we find, of the order Protremata in the Lower Cambrian, several species of *Billingsella* (Pls. LXXXVI–LXXXIX), *Nisusia* (Pls. C and CI), and *Swantonia* (Pl. CIV), all from the upper zone of the Mesonacidæ fauna. (See lists of genera and species, pp. 98–109.)

ATREMATA.

The most primitive form of the Atremata known to me is *Rustella edsoni* (Pl. I, figs. 1, 1a–e) of the upper portion of the Lower Cambrian terrane. It is without a false cardinal area, and there is only a slight indication of a pedicle furrow; some of the less well-preserved shells suggest the protegulum stage of the Brachiopoda. *Mickwitzia* (Pl. VI, figs. 1″ and 3), *Helmersenia* (Pl. LXIII, figs. 7b and 7d), and *Volborthia* (Pl. I, figs. 6 and 6e) have an obscurely defined false cardinal area on the ventral valve. In *Helmersenia* the pedicle opening is produced by the gaping of the valves; in *Volborthia* (fig. 33, p. 366) it is produced by the bulging of the cardinal margins. In *Micromitra* (Pls. II, III, and IV) the posterior margins of the valves may be nearly closed as in *M. pealei* (Pl. III, figs. 3b and 3e′), or have a more or less open delthyrium as in *M.* (*Iphidella*) *pannula* (Pl. IV, figs. 1d, 1f, 2a″, 2b′, 4a′, and 4d′). In *Curticia* (Pl. I, figs. 2′, 2b, 2a″, and 2d) the open delthyrium is more developed than in *Micromitra*, although the cardinal area is not outlined. *Curticia* appears to be a form intermediate in character between *Micromitra* of the Paterinidæ and *Obolus* of the Obolidæ. It shows no trace of a pseudodeltidium or any closing of the delthyrium by an extension of the area across it. In the graphic systematic scheme (p. 317) it is placed as a family descendant from *Obolus*.

In the diagram on page 317 the lines of descent of the various genera are graphically outlined, but our information is often so fragmentary that the scheme is necessarily imperfect. In this the *Rustella* type of the upper Lower Cambrian is assumed as the known form that most nearly approaches the protegulum stage or the first stage in which it would be possible to have a brachiopod preserved as a fossil. From the pre-*Rustella* radicle *Micromitra* developed in early Cambrian time and continued nearly to the close of the Upper Cambrian, giving rise in the Lower Cambrian to *Mickwitzia* and in the Upper Cambrian to *Helmersenia* and *Volborthia*.

Obolus, branching from the *Rustella* protegulum radicle, is first known in the Lower Cambrian a little later than *Micromitra*. It persisted on into the Ordovician, giving rise in early Middle Cambrian time to its subgenera *Palæobolus* and *Westonia*, in late Middle Cambrian time to *Fordinia* and to *O.* (*Acritis?*) *rugatus*. Other subgenera, *Schmidtia*, *Bröggeria*, and *Mickwitzella*, appeared in late Upper Cambrian or early Ordovician time. *Bicia* is taken from the pre-*Obolus* radicle. *Dicellomus* appears in central Middle Cambrian strata and continues into the Upper Cambrian. It probably originated in the *Bicia* phyllum in Lower Cambrian time. *Elkania* begins in central Middle Cambrian strata and continues well into the Upper Cambrian. It appears to have been an offshoot from *Obolus* without known direct descendants. *Neobolus*, with its peculiar platforms pointing to the future Trimerellidæ, is probably a descendant from some Lower Cambrian form that branched off from *Obolus*. The descendants of *Neobolus*, if such existed, are unknown in the late Middle and Upper Cambrian. *Curticia* is given as an offshoot from *Obolus* in Upper Cambrian time and *Lingulobolus* in the Lower Ordovician. *Fordinia* appears to have been an offshoot from *Obolus* in Middle Cambrian time and to have disappeared without descendants.

It is assumed that *Lingulella*-like forms developed from primitive *Obolus* in early Cambrian time, since the genus is first known from the lower portion of the Lower Cambrian and is known to occur throughout the Cambrian and into the Ordovician. The subgenus *Lingulepis* appears in Middle Cambrian time and continues on into the Lower Ordovician. Little is known of *Delgadella* of the Lower Cambrian, but from its form it is referred to the *Lingulella* phyllum. *Lingula* is probably descendant from *Lingulella* in late Cambrian time. *Lingulella davisi* (Pl. XXXI, figs. 6e, 6f) is quite similar to *Lingula*, as are *Lingulella lens*, *L. concinna* (Pl. XXXIII), and other Upper Cambrian species. The subgenus *Leptembolon* branches off from *Lingulella* in late Upper Cambrian time.

Matthew [1902b, p. 98] has given a diagram showing "Conjectural Lines of Descent of the Canadian Oboli with Reference to the Oldest Known Atremata." This diagram and the discussion following it are based upon Matthew's observations in the Cambrian section of New Brunswick and Nova Scotia and his interpretation of the genera and species. The greater opportunity offered by larger collections from a much wider field has so changed the data upon which his conclusions were based that I shall not enter into a discussion of them.

Kutorgina (Pl. V) is assumed to have branched off from the *Micromitra* radicle in pre-Cambrian time, and from its line of descent or radicle *Schuchertina* (Pl. LI, figs. 6, 6a–m) is taken off. Both of these genera are placed on the border line between the Atremata and Protremata.

NEOTREMATA.

The progressive increase in the differences in form and the relations of the two valves in the genera of the Neotremata is best seen by a glance at the diagram on page 317. In this an *Obolella*-like type is descendant from a simple form like the *Rustella* radicle and from this radicle the Acrotretidæ diverges. *Acrothele*, with its great vertical range from the Lower Cambrian to the Ordovician and its wide geographic distribution, is the oldest and simplest form; *Acrotreta* is derived from *Acrothele*, and is first known toward the close of the Lower Cambrian and continues through to the Ordovician; from the *Acrotreta* branch *Acrothyra* and *Discinopsis* diverged in Middle Cambrian time. *Linnarssonella* is assumed to have branched off from the *Acrotreta* radicle, and it is known to have continued from the central Middle Cambrian to later Upper Cambrian time. Another branch from *Acrotreta* leads to *Orbiculoidea* in the central Middle Cambrian, which continues on into the Ordovician. A shell doubtfully identified as *Philhedra* occurs in the Middle Cambrian. If correctly identified it represents the Craniidæ in the Cambrian fauna.

Botsfordia is an offshoot from *Obolella* in the central Lower Cambrian, and I have assumed it to be the progenitor of *Schizopholis* of the Middle Cambrian. *Quebecia* of the middle Lower Cambrian is tentatively shown to be derived from the *Obolella* radicle.

Another branch is *Trematobolus*, which is assumed to be the direct progenitor of the Siphonotretidæ as an offshoot of the *Obolella* primary stock. *Yorkia* is the first known branch from *Trematobolus* in Lower Cambrian time. *Dearbornia*, as known, is limited to the upper portion of the Middle Cambrian.

PROTREMATA.

The ancestral types of the true Protremata are, so far as at present known, *Nisusia* and *Billingsella*. These appear to have come from the radicle leading from *Micromitra* to *Kutorgina* of the Lower Cambrian. *Kutorgina* is placed on the border line between the Atremata and Protremata without direct descendants.

Schuchertina (Pl. LI, figs. 6, 6a–m) has a calcareous shell, smooth outer surface, poorly defined cardinal areas, open delthyrium, and large muscle areas on the ventral valve. It suggests one of the transition forms between *Kutorgina* and *Nisusia*, but as its stratigraphic position is in the central Middle Cambrian, far above and much later in time than the early forms of the lines of descent of the Protremata, it is placed on the border line without descendants.

The earliest representatives of the Nisusiinæ are *Nisusia* and its subgenus *Jamesella;* both occur in the upper portion of the Lower Cambrian. *Nisusia* is unknown later than the upper portion of the Middle Cambrian, and *Jamesella* is unknown above the base of the Upper Cambrian. *Protorthis,* along with its subgenus *Loperia,* is first known in the central portion of the Middle Cambrian; it disappears toward the close of the Upper Cambrian. *Billingsella* is known from the central Lower Cambrian and on to nearly the close of the Upper Cambrian.

Of the genera of the Billingsellidæ other than *Billingsella, Wynnia* occurs in the Middle Cambrian. *Orusia* appears in the upper portion of the Middle Cambrian and continues well up into the Upper Cambrian, and *Otusia* is found in the upper part of the Middle Cambrian. None of these genera appear to have had descendants in Ordovician time. *Wimanella,* although a more primitive form than *Billingsella,* is not known to occur as low down in the Lower Cambrian, and its upper range is only to the upper portion of the Middle Cambrian. It is derived from the *Billingsella* radicle.

Eoorthis is first known from the lower portion of the Middle Cambrian and continues through the Upper Cambrian into the Ordovician. Its line of evolution through *Billingsella* appears to have been from the same radicle as *Nisusia,* which occurs in the upper portion of the Lower Cambrian. The genus *Finkelnburgia* is derived from *Eoorthis* in the lower portion of the Upper Cambrian. The Ordovician genus *Orthis* is assumed to have developed from *Eoorthis* in late Cambrian time, and *Eostrophomena* in the early Upper Cambrian.

Syntrophia, beginning in the lower Middle Cambrian, continues into the Ordovician, and appears to have descendants in *Clarkella* and in *Huenella.*

Swantonia suggests the Rhynchonellidæ in form, but it has a spondylium and it may have been the progenitor of both *Syntrophia* and *Protorthis.* It is represented in the diagram as an offshoot from the radicle of *Nisusia,* without descendants. A review of the characters of the various subgenera of *Orthis* from the Ordovician strata leads us to expect to find representatives of *Dinorthis* in the Cambrian. According to Hall and Clarke [1892a, p. 195] this form is characterized by having the ventral valve depressed so that it is flat or concave over the pallial region, in this respect resembling *Hebertella* [Hall and Clarke, 1892a, p. 198]. Among Cambrian forms *Protorthis* (*Loperia*) *dugaldensis* (Pl. XCIX, figs. 5, 5a–h) of the Middle Cambrian has the depressed ventral valve, but otherwise it differs from *Dinorthis* in having a spondylium in the ventral valve and in the absence of a cardinal process in the dorsal valve. Thus far there appear to be no representatives of *Orthis, Plectorthis, Orthostrophia, Platystrophia, Heterorthis, Bilobites, Dalmanella,* or other Ordovician or Silurian orthoids among the Cambrian species. In endeavoring to trace a genetic connection between the Cambrian Billingsellidæ and the Orthidæ of the Ordovician we are met at once with the great hiatus caused by lack of material for study and comparison from the formations between the Upper Cambrian and the Middle Ordovician. The Orthidæ of the Middle Ordovician include a large group of brachiopods, differing radically from the Billingsellidæ in shell structure, whose ancestral line in the Lower Ordovician and Upper Cambrian is unknown. That this break will be filled is highly probable, but meantime the more or less conjectural lines of descent of various authors must be carefully reviewed in each case in connection with all the stratigraphic and paleontologic evidence afforded by all known Lower Ordovician formations, especially in the American and European areas. Systematic studies now in progress by members of the United States Geological Survey may afford much valuable information that will be of service in this connection.

CLASSIFICATION.

That we may have a graphic illustration to aid in description, the following table and scheme are inserted. The ordinal classification of Beecher [1891], with emendations, is taken as the basis for the orders, while the arrangement of superfamilies is practically that of Schuchert [1897], with such emendations and additions as greater information has rendered necessary.

Table of classification of Brachiopoda.

- ATREMATA.
  - Obolacea.
    - Rustellacea.
      - Rustellidæ — Rustella.
      - Paterinidæ — Mickwitzia. Micromitra. (Paterina). (Iphidella). Volborthia. (?)Helmersenia.
    - Obolidæ.
      - Curticiidæ — Curticia.
      - Obolinæ — Obolus. (Bröggeria). (Palæobolus). (Fordinia). (Lingulobolus). (Mickwitzella). (Acritis). (Schmidtia). (Westonia). Lingulella. (Leptembolon). (Lingulepis). Delgadella.
      - Elkaniinæ — Elkania.
      - Neobolinæ — Neobolus.
      - Biciinæ — Bicia. Dicellomus.
  - Kutorginacea.
    - Kutorginidæ — Kutorgina.
    - Schuchertinidæ — Schuchertina.
- NEOTREMATA.
  - Siphonotretacea.
    - Obolellidæ — Obolella. (Glyptias). Botsfordia. Schizopholis. (?)Quebecia.
    - Siphonotretidæ — Yorkia. Dearbornia. Trematobolus. Schizambon. Siphonotreta. Keyserlingia.
  - Acrotretacea.
    - Acrotretidæ.
      - Acrothelinæ — Acrothele. (Redlichella). Discinolepis.
      - Acrotretinæ — Linnarssonella. Acrotreta. Acrothyra. Discinopsis.
  - Discinacea.
    - Discinidæ — Orbiculoidea.
  - Craniacea.
    - Craniidæ — Philhedra.
- PROTREMATA.
  - Orthacea.
    - Billingsellidæ.
      - Nisusiinæ — Nisusia. (Jamesella). Protorthis. (Loperia.)
      - Billingsellinæ — Wimanella. Billingsella. Orusia. Otusia. Wynnia.
      - Eoorthinæ — Eoorthis. Finkelnburgia.
  - Strophomenacea.
    - Strophomenidæ.
      - Rafinesquinæ — Eostrophomena.
  - Pentameracea.
    - Syntrophiidæ — (?)Swantonia. Syntrophia. Huenella. Clarkella.

Order ATREMATA Beecher [1891, p. 354].

(Emended Schuchert [1897, p. 119] and Walcott [1908e, p. 142].)

Primitive inarticulate corneous or calcareophosphatic Brachiopoda with the pedicle emerging more or less freely between the two valves. Growth takes place in general around the anterior and lateral margins. Specialized forms show tendency to develop rudimentary articulation. Delthyrium originally unmodified, in later genera modified by pseudodeltidia and pseudochilidia, or by thickened, striated, and more or less furrowed or even cleft vertical cardinal margins, the ventral cleft in most specialized forms tending to inclose the pedicle and finally restrict it to the ventral valve; when completely so the genera are referred to the order Neotremata.

Superfamily RUSTELLACEA Walcott [1908e, p. 143].

Primitive, thick-shelled, corneous or calcareophosphatic Atremata developing more or less of pseudodeltidia and pseudochilidia.

Family RUSTELLIDÆ Walcott [1908e, p. 143].

Primitive Rustellacea with the delthyrium small, open, and not much modified by pseudodeltidia or pseudochilidia. Muscle scars and vascular sinuses not well defined in the shell.

Rustella Walcott [1905a, p. 311].

Family PATERINIDÆ Schuchert [1893, p. 151].

(Emended Schuchert [1897, p. 119] and Walcott [1908e, p. 143].)

Progressive Rustellacea with the delthyrium more or less closed by pseudodeltidia or pseudochilidia.

Mickwitzia Schmidt [1888, p. 24].
Micromitra Meek [1873, p. 479].
(*Paterina*) Beecher [1891, p. 345].
(*Iphidella*) Walcott [1905a, p. 305].
Volborthia Kutorga [1848, p. 277].
(?)*Helmersenia* Pander [1861, p. 48].

Superfamily OBOLACEA Schuchert [1896, p. 305].

(Emended Schuchert [1897, p. 119] and Walcott [1908e, p. 143].)

Derived (in Rustellacea), progressive, thick-shelled, calcareophosphatic or corneous Atremata without pseudodeltidia and pseudochilidia. Rounded or linguloid in outline, more or less lens-shaped, and fixed by a short pedicle throughout life to extraneous objects.

Family CURTICIIDÆ Walcott and Schuchert [Walcott, 1908e, p. 143].

Primitive Obolacea with a high well-defined delthyrium. Interior characters much as in Obolidæ.

Curticia Walcott [1905a, p. 319].

Family OBOLIDÆ King [1846].

(Emended Schuchert [1897, p. 119] and Walcott [1908e, p. 143].)

Derived, progressive Obolacea with thickened, striated, vertical cardinal areas traversed by pedicle grooves. Muscles and vascular trunks strongly impressed in the valves.

Subfamily OBOLINÆ Dall [1870, pp. 154 and 161].

(Emended Walcott [1908e, p. 143].)

Primitive Obolidæ with the pedicle grooves more or less shallow or deeply rounded, but never tending to form a sheath or to completely restrict the pedicle opening to the ventral valve. The radicle of the Trimerellidæ, by way of the Neobolinæ, appears to be in this subfamily in the thick-shelled Middle Cambrian forms of *Obolus* (s. s.).

Obolus Eichwald [1829, p. 274].
(*Bröggeria*) Walcott [1902, p. 605].
(*Palæobolus*) Matthew [1895b, p. 201].
(*Fordinia*) Walcott [1908d, p. 64].
(*Lingulobolus*) Matthew [1895b, p. 260].
(*Mickwitzella*) Walcott [1908d, p. 70].
(*Acritis*) Volborth [1869, p. 212].
(*Schmidtia*) Volborth [1869, p. 208].
(*Westonia*) Walcott [1901, p. 683].
Lingulella Salter [1866b, p. 333].
(*Leptembolon*) Mickwitz [1896, p. 199].
(*Lingulepis*) Hall [1863, p. 129].
Delgadella Walcott [1908e, pp. 142 and 144].

Subfamily ELKANIINÆ Walcott and Schuchert [Walcott, 1908e, p. 144].

Divergent Obolidæ with posterior or marginal (not central) platforms, to which are attached the central and outside and middle lateral muscles.

Elkania Ford [1886b, p. 325].

Subfamily NEOBOLINÆ Walcott and Schuchert [Walcott 1908e, p. 144].

Progressive Obolidæ with posterior platforms, to which were probably attached the central and outside and middle lateral muscles. Subfamily apparently progressive from the Obolinæ to the Trimerellidæ, though the platform is posterior and not subcentral as in the trimerelloids.

Neobolus Waagen [1885, p. 756].

Subfamily BICIINÆ Walcott and Schuchert [Walcott, 1908e, p. 144].

Progressive Obolidæ with the pedicle restricted to the ventral valve and more or less inclosed by a pedicle tube, and with rudimentary articulation. The transgressing stock from the Atremata to the Neotremata (Obolellidæ).

Bicia Walcott [1901, p. 676].
Dicellomus Hall [1873, p. 246].

Superfamily KUTORGINACEA Walcott and Schuchert [Walcott, 1908e, p. 144].

Progressive, thick-shelled, almost calcareous atrematous-like shells, tending to be transverse and developing rudimentary articulation, more or less rudimentary cardinal areas, pseudodeltidia, and muscle scars prophetic of the Protremata. Derived out of Rustellacea.

Family KUTORGINIDÆ Schuchert [1893, p. 151].

(Emended Schuchert [1897, p. 131] and Walcott [1908e, p. 145].)

Progressive transverse Kutorginacea with rudimentary cardinal areas, great delthyrial opening, rudimentary articulation, and immature pseudodeltidia. Muscle scars prophetic of the Strophomenacea.

Kutorgina Billings [1861b, p. 9].

Family SCHUCHERTINIDÆ Walcott [1908e, p. 145].

Primitive round Kutorginacea with small cardinal areas. Externally like *Obolus*, with an open subtriangular delthyrium which apparently is without a pseudodeltidium. Muscle scars and vascular markings prophetic, through the Billingsellidæ, of the Strophomenacea.

Schuchertina Walcott [1905a, p. 323].

Order NEOTREMATA Beecher [1891, p. 354].

(Emended Schuchert [1897, p. 129] and Walcott [1908e, p. 145].)

Derived and specialized inarticulate Brachiopoda (through the Obolidæ of the Atremata), as a rule more phosphatic than calcareous, more or less cone-shaped, with the pedicle emerging during life through a perforation or sheath in the ventral valve, or a triangular more or less

open cleft, or only so in the youngest-shelled stage, after which the ventral valve becomes attached by a pedicle to foreign objects. Pedicle cleft in derived forms modified by a listrium. Pseudodeltidia and pseudochilidia as a rule not well developed.

Superfamily SIPHONOTRETACEA Walcott and Schuchert [Walcott, 1908e, p. 145].

Primitive, thick-shelled, calcareous or corneous, oboloid Neotremata, with the pedicle passing through a ventral sheath, the aperture of which may remain apical and circular in outline, or it may become elongate through resorption by passing anteriorly through the protegulum and umbo of the shell. A listrium is not developed. Dorsal protegulum marginal.

Family OBOLELLIDÆ Walcott and Schuchert [Walcott, 1908e, p. 145].

Primitive Siphonotretacea with the pedicle emerging through a small circular perforation in the apex of the ventral valve, posterior to the protegulum. Derived out of the Obolidæ.

Obolella Billings [1861b, p. 7].
(*Glyptias*) Walcott [1901, p. 675].
Botsfordia Matthew [1891, p. 148].
Schizopholis Waagen [1885, p. 752].
(?) *Quebecia* Walcott [1905a, p. 320].

Family SIPHONOTRETIDÆ Kutorga [1848, p. 253].[a]

(Emended Schuchert [1897, p. 130] and Walcott [1908e, p. 146].)

Progressive Siphonotretacea with the circular or elongate pedicle opening at the apex or passing by resorption anteriorly through the protegulum and the umbo of the shell.

Yorkia Walcott [1897b, p. 714].
Dearbornia Walcott [1908d, p. 78].
Trematobolus Matthew [1893a, p. 276].
Schizambon Walcott [1884b, p. 69].
Siphonotreta de Verneuil [1845, p. 286].
Keyserlingia Pander [1861, p. 46].

Superfamily ACROTRETACEA Schuchert [1896, p. 308].

(Emended Schuchert [1897, p. 129] and Walcott [1908e, p. 146].)

Progressive Neotremata with corneous or calcareocorneous shells. The pedicle opening is a simple, circular, more or less conspicuous perforation through the apex of the ventral valve. Dorsal protegulum marginal.

Family ACROTRETIDÆ Schuchert [1893, p. 150].

Same characters as superfamily.

Subfamily ACROTHELINÆ Walcott and Schuchert [Walcott, 1908e, p. 146].

Depressed large Acrotretidæ.

Acrothele Linnarsson [1876, p. 20].
(*Redlichella*) Walcott [1908d, p. 89].
Discinolepis Waagen [1885, p. 749].

Subfamily ACROTRETINÆ Matthew [1903, pp. 74 and 91].[b]

Small Acrotretidæ with more or less high ventral valves.

Linnarssonella Walcott [1902, p. 601].
Acrotreta Kutorga [1848, p. 275].
Acrothyra Matthew [1901b, p. 303].
Discinopsis (Matthew MS.) Hall and Clarke [1892c, p. 105].

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[a] Described as Siphonotretæ.

[b] Wrongly credited to Walcott and Schuchert [Walcott, 1908e, p. 146].

Superfamily **DISCINACEA** Waagen [1885].

(Emended Schuchert [1897, p. 130] and Walcott [1908e, p. 146].)

Derived Neotremata with phosphatic shells, a listrium modifying the pedicle slit, and without pseudodeltidia and false cardinal areas. Dorsal protegulum usually subcentral.

Family **DISCINIDÆ** Gray [1840].

(Emended Schuchert [1897, p. 130] and Walcott [1908e, p. 146].)

Discinacea with an open pedicle notch in early life in the posterior margin of the ventral valve, which is closed posteriorly during neanic growth, leaving a more or less long, narrow slit partly closed by the listrium.

Orbiculoidea d'Orbigny [1847].

Superfamily **CRANIACEA** Waagen [1885].

Cemented calcareous specialized Neotremata without pedicle or anal openings at maturity.

Family **CRANIIDÆ** King [1846].

Craniacea with the pedicle functional probably only during nepionic growth.

Philhedra Koken [1889, pp. 465, 467].

Order **PROTREMATA** Beecher [1891, p. 355].

(Emended Schuchert [1897, p. 131] and Walcott [1908e, p. 147].)

Progressive (though atrematous Kutorginacea), articulate calcareous Brachiopoda with well-developed cardinal areas. The pedicle opening is restricted to the ventral valve throughout life or during early growth, and is often modified and more or less closed by a deltidium. Often there is a chilidium. Brachia unsupported by a calcareous skeleton other than crura.

Superfamily **ORTHACEA** Walcott and Schuchert [Walcott, 1908e, p. 147].

Derived, progressive Protremata. Cruralia and rudimentary spondylia (pseudospondylia) free or cemented (through sessility) directly to the valves. Sometimes without deltidia and chilidia. Cardinal process more or less well developed except in the most primitive genera.

Family **BILLINGSELLIDÆ** Schuchert [1893, p. 152].

(Emended Schuchert [1897, p. 132] and Walcott [1908e, p. 147].)

Primitive Orthacea with an open or more or less closed delthyrium. Cardinal process well developed, rudimentary, or absent. Usually with a clearly defined pseudospondylium, to which the muscles of the ventral valve were attached. Shell structure dense, granular, lamellar, nonfibrous.

Subfamily **NISUSIINÆ** Walcott and Schuchert [Walcott, 1908e, p. 147

Primitive Orthacea with more or less well-developed deltidia and with or without rudimentary chilidia. Spondylia and cruralia rudimentary or small and not supported by septa. Cardinal process rudimentary or absent.

Nisusia Walcott [1905a, p. 247].

(*Jamesella*) Walcott [1905a, p. 252].

Protorthis Hall and Clarke [1892c, p. 273].

(*Loperia*) Walcott [1905a, p. 287].

Subfamily **BILLINGSELLINÆ** Walcott [1908e, p. 148].[a]

Primitive Orthacea very much like Nisusiinæ, but without true spondylia and cruralia. There is a more or less well-developed cardinal process except in Lower Cambrian forms.

Wimanella Walcott [1908d, p. 98].

Billingsella Hall and Clarke [1892b, p. 230].

Orusia Walcott [1905a, p. 273].

Otusia Walcott [1905a, p. 246].

Wynnia Walcott [1908e, pp. 142 and 148].

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[a] This subfamily is wrongly referred to Schuchert, 1893, by Walcott [1908e, p. 148].

Subfamily EOORTHINÆ Walcott [1908e, p. 148].

Derived Orthacea nearly always with large open delthyria; deltidia and chilidia occasionally retained throughout life, but more often only in the younger-growth stages. Cardinal process well developed. Shell structure dense, granular, and with punctate lamellæ.

Eoorthis Walcott [1908d, p. 102].
Finkelnburgia Walcott [1905a, p. 277].

Superfamily STROPHOMENACEA Schuchert [1896, p. 312].

(Emended Schuchert [1897, p. 131] and Walcott [1908e, p. 148].)

Derived, progressive, terminal Protremata, out of Orthacea (Billingsellidæ). Deltidia and chilidia nearly always well developed. Cardinal process always well developed.

Family STROPHOMENIDÆ King [1846].

Subfamily RAFINESQUINÆ Schuchert [1893, p. 153].

(Emended Schuchert [1897, p. 132] and Walcott [1908e, p. 148].)

Strophomenoids having generally a convex ventral and a concave or nearly flat dorsal valve.

Eostrophomena Walcott [1905a, p. 256].

Superfamily PENTAMERACEA Schuchert [1896, p. 320].

(Emended Schuchert [1897, p. 134] and Walcott [1908e, p. 148].)

Specialized Protremata with well-developed free or supported spondylia and cruralia. Deltidia and chilidia usually absent.

Family SYNTROPHIIDÆ Schuchert [1896, p. 320].

(Emended Schuchert [1897, p. 135] and Walcott [1908e, p. 148].)

Primitive Pentameracea with long, straight cardinal areas.

(?) *Swantonia* Walcott [1905a, p. 296].
Syntrophia Hall and Clarke [1892c, p. 270].
Huenella Walcott [1908d, p. 109].
Clarkella Walcott [1908d, p. 110].

DESCRIPTION OF GENERA AND SPECIES.

Order ATREMATA Beecher.

[*a*, without; and τρῆμα, perforation.]

Superfamily RUSTELLACEA Walcott.

Family RUSTELLIDÆ Walcott.

Genus RUSTELLA Walcott.[a]

Rustella Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 311. (Mentioned as a new genus, the type species being described.)

Rustella Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 143. (Classification of genus.)

This genus is founded on *Rustella edsoni* Walcott. It appears to be the most primitive form of brachiopod known. The single specimen of *Rustella? major* (Matthew) does not add to our knowledge of this genus, and it may belong to some other genus.

The generic name is given in memory of William P. Rust, of Trenton Falls, Oneida County, New York, whose collections from the Lower Cambrian strata of Georgia, Franklin County, Vermont, were the most extensive and the material the finest obtained there, so far as known to me.

Rustella edsoni Walcott.

Plate 1, figures 1, 1a–e.

Obolella (*Kutorgina*) *cingulata* Billings (in part), 1861, Geol. Survey Canada, Paleozoic Fossils, vol. 1, p. 8, fig. 9 (not figs. 8 and 10, which represent specimens of the true *Kutorgina cingulata*). (Described and discussed as a new species.)

Obolella (*Kutorgina*) *cingulata* Billings (in part), 1861, Report on the Geology of Vermont, vol. 2, p. 948, fig. 348 (not figs. 347 and 349). (Copy of preceding reference.)

Obolella (*Kutorgina*) *cingulata* Billings (in part), 1862, Report on the Economic Geology of Vermont, by Hager, p. 220, fig. 348 (not figs. 347 and 349). (Copy of preceding reference.)

Obolella cingulata Billings, 1863, Geol. Survey Canada, Fifteenth Rept. Progress, p. 284, fig. 287c (not figs. 287a and 287b, which represent specimens of the true *Kutorgina cingulata* and are copied from Billings, 1861b, p. 8, figs. 8 and 10, respectively). (No text reference. Fig. 287c is copied from Billings, 1861b, p. 8, fig. 9.)

Kutorgina cingulata Walcott (in part) [not (Billings)], 1886, Bull. U. S. Geol. Survey No. 30, p. 103, Pl. IX, figs. 1g and 1h (not figs. 1, 1a–f, which represent specimens of the true *Kutorgina cingulata*). (Specimens now referred to *Rustella edsoni* are here mentioned in the discussion of *Kutorgina cingulata* as representing a possible distinct species. The specimens represented by figs. 1g and 1h are redrawn in this monograph, Pl. I, figs. 1a and 1, respectively.)

Kutorgina cingulata Walcott (in part) [not (Billings)], 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 609, Pl. LXIX, figs. 1g and 1h (not figs. 1, 1a–f, which represent specimens of the true *Kutorgina cingulata*). (No text reference. Figs. 1g and 1h are copied from figs. 1g and 1h of the preceding reference.)

Rustella edsoni Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 311–312. (Described and discussed as below as a new species.)

General form subcircular, biconvex. Ventral valve moderately convex, with the apex at the margin immediately above a low arch in the posterior margin. Surface smooth except for concentric growth lines and low ridges that in some shells are quite prominent. A shallow, broad, rudimentary pedicle groove occurs beneath the apex and on a slightly flattened space adjoining the posterior margin. Dorsal valve about as convex as the ventral and with the apex marginal. The interior of the valve shows two rounded depressions beneath the umbo with a slight, narrow groove between them; a little in advance the outlines of the central muscle scars occur; rather strong but faintly indicated radiating lines occur toward the front.

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[a] Before *Rustella* was proposed by Walcott [1905a, p. 311] the species now included under the genus were placed in the following genera:

Obolella (*Kutorgina*) Billings [1861b, p. 8; 1861c, p. 948; 1862e, p. 220].
Obolella Billings [1863, p. 284].
Kutorgina Walcott [1886b, p. 103].
Obolus Matthew [1890, p. 155].
Kutorgina Walcott [1891a, p. 609].
Mickwitzia Mickwitz [1896, p. 23].

Observations.—This shell was identified as the dorsal valve of *Kutorgina cingulata* by Billings [1861b, p. 8, fig. 9] and as the ventral valve of the same species by myself [1886b, p. 102, Pl. IX, figs. 1g and 1h, and 1891a, p. 609, Pl. LXIX, figs. 1g and 1h]. They were considered as distorted, flattened shells. Better material shows them to represent one of the simplest forms of brachiopod known; with the exception of the rudimentary pedicle furrow and area there is nothing more than the gaping valve, much like Charles E. Beecher's ideal "*Paterina*" [1891, p. 345].

The specific name is given in recognition of the excellent work of Mr. George Edson, of St. Albans, Vermont, in collecting the Lower Paleozoic fossils of that region.

FORMATION AND LOCALITY.—**Lower Cambrian**: (25)[a] *Sandstone just above Parker's quarry, near Georgia;* and (319r) on the Bullard farm about 2 miles (3.2 km.) east of Swanton; both in Franklin County, Vermont.

(392o) Arenaceous limestone collected somewhere in Vermont (exact location unknown).

(49) Sandstone on Codorus Creek, 0.125 mile (0.2 km.) below Meyer's mill, near Emigsville; and (49a) sandstone on the Liverpool road, south of the schoolhouse, 3 miles (4.8 km.) northwest of York; both in York County, Pennsylvania.

RUSTELLA? MAJOR (Matthew).

Text figure 19.

Obolus? major MATTHEW, 1890, Trans. Roy. Soc. Canada for 1889, 1st ser., vol. 7, sec. 4, No. 12, p. 155, Pl. VIII, fig. 3. (Described and discussed as a new species; see below for copy of description. The specimen represented by fig. 3 is redrawn below, fig. 19.)

Mickwitzia? major (Matthew), MICKWITZ, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, p. 23. (Discussed in German.)

FIGURE 19.—*Rustella? major* (Matthew). A, A', Cast from a natural mold in sandstone; side outline restored. From Locality 301v, Lower Cambrian shales on Hanford Brook, New Brunswick. The original mold is in the collections of the University of Toronto. The cast from which the figure was drawn is in the collections of the U. S. National Museum, Cat. No. 51462. This specimen was figured by Matthew [1890, Pl. VIII, fig. 3].

The original description by Matthew follows:

Only the dorsal valve known. This is transversely oval, flattened near the umbo, and deep within the edges toward the back of the shell.

The interior markings seem those of an *Obolus*. The median line is strongly marked just within the umbo, and at the middle of the shell, in front of which it appears to fork. The scars of the posterior laterals only are distinct.

The example known shows the interior of the shell and a little of the external surface. The shell was thin, and is changed to iron oxide. The outer surface near the edge of the shell was covered by fine radiating lines or ridges.

Observations.—The type and only specimen of this form is preserved as a natural mold in an impure sandstone; the original shell had been removed, and the resulting mold is very similar to those of *Rustella edsoni* (Pl. I, figs. 1 and 1a) from a fine-grained sandstone; in the case of the latter species only a film remains to indicate the original shell, while in the calcareous nodules embedded in the sandstone the shell is shown to be of considerable thickness.

The reference to the genus *Rustella* is based on the similarity in size and form between this species and *Rustella edsoni* and the fact that *Rustella? major* occurs at about the same stratigraphic horizon in the Lower Cambrian as *R. edsoni* and below the recognized Middle Cambrian fauna. At the same locality and at about the same horizon I found several Lower Cambrian fossils: *Micromitra* (*Paterina*) *labradorica*, *Hyolithes* cf. *communis*, *Coleoloides* cf. *typicalis* [Walcott, 1900, p. 322].

FORMATION AND LOCALITY.—**Lower Cambrian**: (301v [Matthew, 1890, p. 155]) Sandy shales of Division 2b of the "Basal series" of Matthew, on Hanford Brook, St. John County, New Brunswick, Canada.

[a] The type locality is in italics; where there is but one locality, however, this will not be italicized. When a locality is not represented in the collections of the United States National Museum, the authority for its citation is given immediately after the locality number, or at the end of the paragraph, if several can be grouped under the one reference.

Family PATERINIDÆ Schuchert.

Genus MICKWITZIA Schmidt.[a]

Mickwitzia Schmidt, 1888, Mém. Acad. imp. sci. St.-Pétersbourg, 7th ser., vol. 36, No. 2, p. 24. (Described in German as a new genus.)

Mickwitzia Schmidt, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 246. (Described.)

Mickwitzia Schmidt, Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, p. 562. (Copy of preceding reference.)

Mickwitzia Schmidt, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 86–87. (Described and discussed.)

Causea Wiman, 1902, Bull. Geol. Inst. Univ. Upsala, vol. 6, pt. 1, No. 11, pp. 53–54. (Described and discussed in German as a new genus, the description being incorporated with that of the type species, *Causea formosa*.)

Mickwitzia Schmidt, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 143. (Classification of genus.)

Shell large, unequivalve. Ovate or subcircular, with apex of valves within the margin and erect, or curved over the margin. A false cardinal area may or may not be obscurely defined; valves not articulated. Shell substance mostly calcium phosphate and arranged in three principal layers. The outer layer is papillose, with fine and large punctæ; middle layer marked by numerous radiating and concentric, more or less elevated lines and small punctæ that become very numerous toward the front margins of the shell; inner layer marked by large punctæ or vertical canals and often a thickening of shell substance that takes the form of irregular serpentine ridges penetrated by vertical canals.

Type.—Lingula? monilifera Linnarsson.

Observations.—Both Schmidt [1888, p. 24] and Hall and Clarke [1892c, pp. 86–87] define and discuss this genus, but with the new material I have for study, a new diagnosis has been prepared. The genus appears to fall within the order Atremata Beecher [1891, p. 354] and the family Paterinidæ Schuchert [1897, p. 119]. The latter family has heretofore included only the genus *Micromitra*. The species of *Mickwitzia* include chitinous or phosphatic shells with elevated ventral valve, having an apex elevated within the margin (*Mickwitzia formosa* (Wiman)), or arching over the margin (*Mickwitzia monilifera* (Linnarsson)). *Micromitra* has a clearly marked area and pseudodeltidium, in this respect being further advanced in evolution than *Mickwitzia*. A series of shells of *Mickwitzia* might show a more strongly marked false area in the young shell than in the adult forms.

The generic name was given in honor of Dr. A. Mickwitz.

Mickwitzia formosa (Wiman).

Plate VI, figures 3, 3a–c.

Causea formosa Wiman, 1902, Bull. Geol. Inst. Univ. Upsala, vol. 6, pt. 1, No. 11, pp. 53–54, Pl. II, figs. 1–5. (Described and discussed in German as a new species. The specimen represented by figs. 1–5 is redrawn in this monograph, Pl. VI, figs. 3, 3a–c.)

Outline of ventral valve circular; apex a little in front of the posterior margin, strongly elevated, and rising vertically above a broad, obscurely defined false area. The area is defined by a rounded angle where the transverse, slightly convex posterior surface below the apex unites with the lateral slopes from the apex. The posterior margin is slightly arched, so as to form an opening between it and the dorsal valve.

Only the inner layers of the shell are preserved on the type specimen, the outer epidermal layer having been exfoliated. On the posterior portion of the shell the second or middle layer has the radiating and concentric lines typical of *Mickwitzia monilifera* (Linnarsson). Toward the front the layer of shell is marked by faint radiating lines and many fine punctæ, exactly as in specimens of *M. monilifera*, where the outer layer is exfoliated. This type of surface is

[a] Prior to the definition of *Mickwitzia* by Schmidt [1888, p. 24], the species now referred to this genus were placed under the following genera:
Lingula Linnarsson [1869a, p. 344; 1869b, p. 398]. *Obolus* Linnarsson [1871, pp. 9–10].

shown by Plate VI, figure 1k, except that the punctæ are very few on the center of the shell, which is the part enlarged by the figure. The inner layer of shell of *M. formosa* has numerous large punctæ that penetrate it, and also the irregular serpentine ridged shell deposits characteristic of this species and of many adult shells of *M. monilifera*.

Observations.—Wiman [1902, p. 53] created the genus *Causea* to receive this species. He very kindly sent me the type material for study, and with it a fine collection of *M. monilifera* (Linnarsson). I am unable to determine generic distinctions between the two species. The shell substance and structure are the same, so far as material exists for comparison. *Mickwitzia formosa* has a more elevated apex and is a much larger shell, but these are specific rather than generic distinctions.

FORMATION AND LOCALITY.—**Middle? Cambrian:** (**311l** [Wiman, 1902, p. 57]) *Drift bowlder of bluish calcareous sandstone, No. 31, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.*

(**311s** [Wiman, 1902, p. 57]) Drift bowlder of gray quartzitic sandstone, at Skarpnåtö, Åland Island, Finland, Russia.

MICKWITZIA MONILIFERA (Linnarsson).

Plate VI, figures 1, 1a–p; Plate LIX, figure 2.

Lingula? monilifera LINNARSSON, 1869, Öfversigt af K. svensk. Vet.-Akad. Förhandl. for 1869, Bd. 26, No. 3, p. 344, Pl. VII, figs. 1 and 2. (Described and discussed in Swedish as a new species.)

Lingula monilifera LINNARSSON, 1869, Geol. Mag., vol. 6, p. 398, Pl. XI, figs. 1 and 2. (Text translated into English from Linnarsson, 1869a, p. 344. Figs. 1 and 2 are copied from Linnarsson, 1869a, Pl. VII, figs. 1 and 2.)

Obolus? monilifer LINNARSSON, 1871, Bihang till K. svensk. Vet.-Akad. Handl., Bd. 9, No. 7, pp. 9–10, Pl. I, figs. 2 and 3. (Described and discussed in Swedish.)

Mickwitzia monilifera (Linnarsson), SCHMIDT, 1888, Mém. Acad. imp. sci. St.-Pétersbourg, 7th ser., vol. 36, No. 2, pp. 21–23 and 24–25, Pl. II, figs. 6–26. (Described and discussed in German. Figs. 12c and 12d are copied in this monograph, Pl. VI, figs. 1p and 1o, respectively.)

Mickwitzia monilifera (Linnarsson), WALCOTT, 1891, Tenth Ann. Rept. U. S. Geol. Survey, Pl. LXX, figs. 2, 2a–h. (No text reference. Figs. 2, 2a–f are copied from Schmidt, 1888, Pl. II, figs. 16a, 16c, 16b, 12b, 12c, 12d, and 12a, respectively. Fig. 2h is copied from Linnarsson, 1871, Pl. I, fig. 2.)

Mickwitzia monilifera (Linnarsson), HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, figs. 253–255, p. 246. (No text references. Figs. 253–255 are copied from Schmidt, 1888, Pl. II, figs. 14a, 8b, and 16b, respectively.)

Mickwitzia monilifera (Linnarsson), HALL and CLARKE, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, figs. 253–255, p. 562. (Copy of preceding reference.)

Mickwitzia monilifera (Linnarsson), HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 86, figs. 42–44. (No text reference. Figs. 42–44 are copied from Schmidt, 1888, Pl. II, figs. 14a, 8b, and 16b, respectively.)

Mickwitzia monilifera (Linnarsson), WIMAN, 1902, Bull. Geol. Inst. Univ. Upsala, vol. 6, pt. 1, No. II, p. 53, Pl. II, figs. 12–14, Pl. IV, figs. 2 and 3. (Characterized and discussed in German.)

General form ovate to subcircular; biconvex or subplanoconvex.

Surface of exterior of the shell papillose; each papilla is about as high as the width of its base, and the apex is perforated by a minute tube. There appears to be no systematic arrangement of the papillæ; they are thickly set over the entire surface of a dorsal valve 20 mm. in diameter; on some parts of the shell the papillæ are closely arranged in undulating, irregular ridges; these, when worn by attrition, have the appearance shown by Plate VI, figure 1m. This outer surface is rarely preserved, as it usually adheres to the matrix, leaving the second layer exposed to view. The layer of shell immediately beneath the outer shell is marked by concentric, elevated, minutely undulating, raised, closely set lines that are crossed by fine, radiating, closely set raised lines (Pl. VI, figs. 1k and 1l); this is the surface illustrated by Linnarsson [1869b, Pl. XI, fig. 2] and Schmidt [1888, Pl. II, fig. 21]; it is seen on most specimens preserving the shell. The distance from the apex, condition of preservation, etc., cause great variation in the appearance of the inner layer. Scattered punctæ penetrate the inner layer, and often the depressions between the concentric and radiating raised lines give the surface a finely and regularly pitted or punctate appearance. On some shells the punctæ are numerous and regularly arranged toward the front of the shell. The inner surface of the inner layer of the shell is marked by strong punctæ in adult shells. Frequently a shell deposit is found over the inner

surface which is punctate and curiously ridged, very much like the outer surface in partly worn shells. (See Pl. VI, fig. 1m, of the outer surface.)

Substance of shell mostly calcium phosphate [Schmidt, 1888, p. 23]. The shell is thick in small shells, but does not increase proportionately in thickness with age.

The largest shell in the collection before me has a length of 32 mm., exclusive of extension of apex over area; width 30 mm.

Ventral valve convex, with apex projecting a little over the posterior margin. A false area is more or less definitely outlined; in some specimens it is quite clear and in others very indefinite; it is much like some of the less clearly defined false areas of species of *Micromitra*. When well defined the posterior margin of the valve arches slightly, as in Plate VI, figure 1e.

Dorsal valve slightly convex, with a very low submarginal apex. The interior of the valve is usually without traces of muscular or vascular markings. In one worn shell a median sinus occurs, and what appears to be the path of advance of the anterolateral muscle scars (Pl. VI, fig. 1f); another unworn shell shows a trace of radiating lines near the median line; and a third has two plainly marked muscle scars a little in advance of the apex and some distance from the median line; these occupy the position of the posterior muscle scars as they occur in the dorsal valve of *Schizocrania*.

Observations.—The preceding description is based on specimens in the collection of the United States National Museum. Mr. Schmalensee, a collector in the Geological Survey of Sweden, at my request collected a number of fine specimens for the United States National Museum. The museum has also received a number of casts from other sources.

Schmidt [1888, p. 22] describes a hooked process as occurring in a cast of a dorsal valve. After noting his expression of doubt as to whether the process belonged to the shell, and also after a study of the interiors of finely preserved dorsal valves, I can not retain the view that such a process exists in the dorsal valve of this species. We may attribute the apparent occurrence of it in the cast studied by Schmidt to the accidental attachment of some foreign body, or it may be that the cast belongs to some other genus and species.

There is no other species of the genus that is closely related to *Mickwitzia monilifera; M. formosa* has the same general character of shell, but its ventral valve is more erect, much larger, and it differs a little in the details of the surfaces of the interior layers of the shell.

Formation and locality.—**Middle? Cambrian:** (**311l** [Wiman, 1902, p. 57]) Drift bowlder of bluish calcareous sandstone, No. 31, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg; and (**311u** [Wiman, 1902, p. 57]) drift bowlder of blue calcareous sandstone, Söderarm lighthouse, near Norrtelje, Province of Stockholm; both in Sweden.

(**311e**) Drift bowlder of rusty sandstone, south of Lumparn, parish of Jomala; (**311f**) drift bowlder of gray quartzitic sandstone, at Slemmern, Mariehamn; (**311q**) drift bowlder of gray quartzitic sandstone, at Ytternäset, Mariehamn; and (**311r**) drift bowlder of gray quartzitic sandstone, at Granboda, Lemland; all [Wiman, 1902, p. 57] on Åland Island, Finland, Russia.

Lower Cambrian: (**390j**) *Eophyton sandstone at Lugnås, 8 miles (12 km.) south-southwest of Mariestad, Province of Skaraborg;* and (**390k**) *Eophyton* sandstone at Prestorp, north of the hill of Billingen, Province of Skaraborg; both in Sweden.

(**396q**) Upper boundary of the blue clay with the Fucoid sandstone, the "*Mickwitzia* conglomerate" at Reval; (**396r**) in the "upper strata" at Streitberg, near Reval; (**396s**) in loose blocks on Kosch Brook near Likkat, near Reval; (**396t**) at the sandstone capes of Ziegelskoppel, Kakkomaggi (also Rocca al Mare), near Reval; (**396u**) in loose blocks on the lower course of Jaggowal Brook, about 20 miles (32.2 km.) east-southeast of Reval; (**396v**) at the upper boundary of a dolomitic sandstone with which the *Olenellus* stratum begins, below the cement factory on Kunda Brook;[a] and (**396w**) in the glauconitic sands above the main mass of the clay, below the cement factory on Kunda Brook; all [Schmidt, 1888, p. 24] in the Government of Esthonia, Russia.

Mickwitzia occidens Walcott.

Plate VI, figure 4.

Mickwitzia occidens Walcott, 1908, Smithsonian Misc. Coll., vol. 8, No. 3, p. 54, Pl. VII, fig. 1. (Described as below as a new species. Fig. 1 is copied in this monograph, Pl. VI, fig. 4.)

Only crushed and broken specimens of this shell are available. One of these shows that the apex of the ventral valve was a little above the posterior margin of the shell, very much as

[a] Specimens of this species from the locality on Kunda Brook are included in the collections of the United States National Museum.

in *Mickwitzia pretiosa* Walcott. The outline of the valves appears to have been ovate to subcircular and the ventral valve moderately convex. The shell is phosphatic or chitinous and built up of three principal layers. The outer layer is thin, and thickly set with minute pustules or granules that give the surface a roughened appearance. When the outer layer is exfoliated, which is usually the case, the middle layer presents a smooth, shining surface that is marked by a few concentric striæ and numerous fine radiating striæ, between which many minute punctæ occur. The inner layer shows minute, irregular, serpentine, rounded ridges, perforated by vertical canals or punctæ. An interior of a ventral valve shows the lines of advance of the anterolateral muscle scars. The largest shell indicated on the surface of the siliceous shale has a length and width of 12 mm.

The generic reference of this species is based on the apex of the ventral valve and the structure and character of the shell.

FORMATION AND LOCALITY.—**Lower Cambrian**: (**53**) Sandstones in the lower portion of 3d of the Waucoba Springs section [Walcott, 1908f, pp. 187 and 188], 1 mile (1.6 km.) east of the Saline Valley road, about 2.5 miles (4 km.) east-northeast of Waucoba Springs, Inyo County, California.

(**174c**) *Sandstones on small hill in the salt flat, 1 mile (1.6 km.) northeast of Silver Peak Mill, Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County, Nevada.*

MICKWITZIA PRETIOSA Walcott.

Plate VI, figure 2.

Mickwitzia pretiosa WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 54–55, Pl. VII, fig. 2. (Described and discussed as below as a new species. Fig. 2 is copied in this monograph, Pl. VI, fig. 2.)

This species is founded on a single specimen of a ventral valve. It has a length of 7 mm., width 6.5 mm. Outline subcircular, slightly convex; apex curved over toward the posterior margin and projecting beyond it. False area short and obscure. Surface marked by radiating raised lines that at the front margin show six in a distance of 2 millimeters. Fine papillæ are thickly scattered over the surface, with a tendency to follow concentric lines of growth on some portions of the shell, and on others they appear on low, narrow, serpentine ridges, as in *M. monilifera* (Linnarsson). A few large punctæ are scattered here and there over the surface. Inner surfaces and layers of shell unknown.

This beautiful shell differs in the details of its surface from *M. monilifera;* it is also less convex, and the apex is nearer the posterior margin.

FORMATION AND LOCALITY.—**Lower Cambrian**: (**390j**) *Eophyton* sandstone at Lugnås, 8 miles (12.8 km.) south-southwest of Mariestad, Province of Skaraborg, Sweden.

MICKWITZIA? sp. undt.

Lingula hawkei? BORNEMANN [not ROUAULT], 1891, Nova Acta Acad. Cæs. Leop.-Carol. Germanicæ Naturæ Curiosorum, Bd. 56, No. 3, p. 439, Pl. XIX, figs. 19–20. (Characterized and discussed in German.)

Bornemann describes and illustrates some large shells 3 centimeters or more in diameter from the *Olenopsis* beds, which he states are characterized by a somewhat quadrangular outline and faint sinus and resemble Barrande's "*Lingula feistmanteli.*" I am inclined to compare this form with the large compressed casts of *Mickwitzia monilifera* and to make a tentative reference to the genus *Mickwitzia*. The shell is certainly not *Lingula rouaulti* Salter.

FORMATION AND LOCALITY.—**Middle? Cambrian**: (**354a** [Bornemann, 1891, p. 439]) in grayish-white quartzitic sandstones in the valley of Gutturu Sartu, island of Sardinia, Italy.

Genus MICROMITRA Meek.[a]

[μικρός, small; and mitra, a hat.]

Not *Iphidea* BALY, 1865, Entom. Monthly Magazine, vol. 2, p. 127. (Proposed for a genus of Coleoptera.)

Iphidea BILLINGS [not BALY], 1872, Canadian Naturalist, 2d ser., vol. 6, No. 4, pp. 477–478. (Type species ("*Iphidea bella*") described and discussed and "*Iphidea*" mentioned as a new genus. The reference is copied in this monograph under *Micromitra (Paterina) bella*, p. 345.)

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[a] The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Micromitra* were formerly placed; it includes only those references in which the genus is discussed or described. For the sake of completing the record the remaining mere generic references are here listed:

Kutorgina Linnarsson [1876, p. 25].
Kutorgina Hall and Whitfield [1877, p. 207].
Kutorgina Walcott [1884b, p. 20].
Kutorgina Matley [1902, p. 146].
Kutorgina Grönwall [1902, p. 40].

Micromitra Meek, 1873, Sixth Ann. Rept. U. S. Geol. and Geog. Survey Terr. for 1872, p. 479. (Suggests *Micromitra* as a new generic name for "*Iphidea* (*??*) *sculptilis*" if that species should prove to belong to a new genus. This reference is quoted in this monograph, p. 334.)

Iphidea Billings, 1874, Geol. Survey Canada, Paleozoic Fossils, vol. 2, pt. 1, p. 76. (Copied from Billings, 1872b, pp. 477–478.)

Iphidea Billings, Linnarsson, 1876, Bihang till K. svensk. Vet.-Akad. Handl., Bd. 3, No. 12, p. 26. (Mentioned in English in the discussion of "*Iphidea ornatella*.")

Iphidea Billings, Dall, 1877, Bull. U. S. Nat. Mus., No. 8, p. 39. (Mentioned.)

Iphidea Billings, Walcott, 1886, Bull. U. S. Geol. Survey No. 30, pp. 100–101. (Copies the original description, Billings, 1872b, pp. 477–478, of the type species ("*Iphidea bella*") and discusses genus.)

Kutorgina Walcott (in part), [not Billings], 1886, Idem, pp. 101–102. (Genus *Kutorgina* described, but description also includes reference to specimens now referred to *Micromitra*, *Micromitra* (*Paterina*), and *Micromitra* (*Iphidella*).)

Iphidea Billings, Oehlert, 1887, Manuel de conchyliologie, by Fischer, p. 1270. (Described in French.)

?Iphidea Billings, Hall and Clarke (in part), 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 249 (Described, but accompanied by figures of specimens belonging with the subgenus *Paterina*.)

?Iphidea Billings, Hall and Clarke (in part), 1892, Forty-fifth Ann. Rept. New York State Mus. for 1891, p. 565 (Copy of preceding reference.)

Kutorgina Walcott, Hall and Clarke (in part), 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 90–94 (Copies Walcott's description, 1886b, pp. 101–102, and discusses genus, but description and discussion also include reference to specimens now referred to *Micromitra*, *Micromitra* (*Paterina*), *Micromitra* (*Iphidella*), *Protorthis*, and *Billingsella*.)

Iphidea Billings, Hall and Clarke, 1892, idem, pp. 97–98. (Copies the original description, Billings, 1872b, pp. 477–478, of the type species ("*Iphidea bella*") and discusses genus.)

Iphidea Billings, Walcott (in part), 1897, Proc. U. S. Nat. Mus., vol. 19, pp. 707–711. (Discussed. The genus includes species now referred to *Micromitra*, *Micromitra* (*Paterina*), and *Micromitra* (*Iphidella*).)

Iphidea Billings, Schuchert (in part), 1897, Bull. U. S. Geol. Survey No. 87, p. 233. (Merely refers *Micromitra* and *Paterina* to *Iphidea*.)

Iphidea Billings, Walcott, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, pp. 447–448. (Mentioned in discussion of "*Iphidea sculptilis*.")

Iphidella Walcott (in part), 1905, Proc. U. S. Nat. Mus., vol. 28, p. 304. (Merely proposed to replace *Iphidea*, but includes reference to specimens belonging with *Micromitra*, *Micromitra* (*Paterina*), and *Micromitra* (*Iphidella*).)

Paterina (*Micromitra*) (Meek), Schuchert, 1905, Am. Jour. Sci., 4th ser., vol. 19, p. 329. (Suggests that *Micromitra* be used in a subgeneric sense, under *Paterina*, for the forms typified by *Micromitra sculptilis*.)

Not *Iphidea* Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 201. (Described, but the species placed under it belong with the subgenera *Paterina* and *Iphidella*.)

Micromitra Meek, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 143. (Classification of genus.)

Ventral valve conical (*Micromitra* (*Paterina*) *etheridgei* (Tate), Pl. III, fig. 10) to depressed conical (*M.* (*P.*) *labradorica* (Billings), Pl. II, fig. 2), with the beak curving more or less over a false area which is divided midway by a triangular fissure that may be covered almost entirely (*M.* (*P.*) *superba* (Walcott), Pl. II, fig. 1) or only in part (*Micromitra* (*Iphidella*) *ornatella* (Linnarsson), Pl. III, fig. 6) by a convex pseudodeltidium.

Dorsal valve slightly to moderately convex. Beak small and usually curved a little over a low area (*Micromitra pealei* (Walcott), Pl. III, fig. 3e′) that has a rather broad pseudodeltidium.

Surface marked by concentric lines of growth and fine radiating striæ (*Micromitra* (*Paterina*) *labradorica* (Billings)); crenulated concentric striæ that give a more or less distinctly crenulated appearance to the surface (*Micromitra sculptilis* (Meek)); and strongly crenulated concentric striæ forming a network of raised, obliquely arranged lines that divide the surface into minute pits (*Micromitra* (*Iphidella*) *pannula* (White)).

Shell substance corneous. Shell built up of thin layers or lamellæ that are more or less oblique to the outer surface.

Very little is known of the interior of the valves. The ventral valve of *Micromitra* (*Paterina*) *labradorica* (Billings) (Pl. II, fig. 2c) has a few lines or ridges that radiate from the beak very much as in *Kutorgina* (Pl. V, fig. 1). The dorsal valve also shows radiating ridges (*Micromitra* (*Iphidella*) *ornatella* (Linnarsson) Pl. III, fig. 6d), and in addition an exfoliated shell of *M.* (*I.*) *pannula ophirensis* Walcott shows a median ridge, the base of the main vascular sinuses, and two central muscle scars (Pl. IV, fig. 4e).

Type.—*Iphidea* (*??*) *sculptilis* Meek [1873, p. 479].

Meek's original reference to *Micromitra* [1873, p. 479] is as follows:

> It is quite probable that when specimens showing clearly all the characters of this shell can be examined it will be found to belong to an undefined genus, either of the Brachiopoda or some other group. In this case I would propose for this genus the name *Micromitra*.

The type specimen labeled by Meek in 1873 as *Iphidea* (*Micromitra*) *sculptilis* is in the collections of the United States National Museum (Catalogue No. 7864). The label is in Meek's handwriting and firmly attached to the specimen of rock containing the shell.

The description of the shell referred to *Iphidea* (*??*) *sculptilis* Meek [1873, p. 479] is that of the ventral valve. While no generic description is given and the specific description is incomplete, we are necessitated by the present rules of nomenclature to accept the name *Micromitra*, since *Iphidea*, as proposed by Billings [1872b, p. 477], was preoccupied by Baly in 1865.

When away, engaged in field work, I accidentally discovered that the genus *Iphidea* was first used by Baly in 1865. I then put the name *Iphidella* in some manuscript notes and by oversight this name was published [Walcott, 1905a, p. 304]. Schuchert [1905, p. 329] called attention to its being a synonym of *Micromitra* and *Paterina*. This is shown in my synonymy of the genus *Iphidea* [1897b, p. 707]. I now use *Iphidella* as a subgenus of *Micromitra*.

Billings's description of the genus *Iphidea* and that of the type species were combined. At the time of my study of *Kutorgina* and *Iphidea* [Walcott, 1886b, p. 100] I did not agree with Billings in his reference of "*Obolus labradoricus*" to *Iphidea* [Billings, 1874, p. 76]. Since that time I have collected more material representing this group of shells, and from its study have come to the conclusion that Billings was correct in referring "*O. labradoricus*" to his genus *Iphidea*. The ventral valve of "*O. labradoricus*" has a narrow false area of the same type as *Micromitra* (*Paterina*) *bella* (Billings), and the characteristic pseudodeltidium is clearly shown in a section, and it is known to occur in *Micromitra sculptilis* (Meek), *Micromitra* (*Iphidella*) *ornatella* (Linnarsson), and *M.* (*I.*) *pannula* (White). The extreme development of the false area and pseudodeltidium is found in *M.* (*P.*) *superba* (Walcott), from the Middle Cambrian "Tonto" sandstone of the Grand Canyon of the Colorado. In this form the ventral valve is broadly conical, and the large pseudodeltidium projects backward at an angle equal to the slope from the apex to the front. In *Micromitra* (*Paterina*) *bella* the false area slopes more abruptly downward and in *Micromitra* (*Iphidella*) *ornatella* it is nearly vertical, the pseudodeltidium being much shorter and projecting but a short distance beyond the area. The slope of the area of *M.* (*I.*) *ornatella* is essentially the same as that of *Micromitra* (*Paterina*) *labradorica swantonensis* (Walcott), which is the type of Beecher's genus *Paterina*. (See p. 344.) In some specimens of the latter species the beak projects so that the slope of the area carries it forward to a considerable distance under the beak. This is also true of *Micromitra* (*Iphidella*) *pannula*.

The presence of an apical foramen in *Micromitra* (*Paterina*) *bella* and *Micromitra* (*Iphidella*) *ornatella* would separate those species from the Paterinidæ, but from a careful study of all the evidence attainable I am led to question the presence of a true apical foramen in either species. Unless there are other characters than those shown by the false area and pseudodeltidium and the angle at which they slope, it will be impracticable to generically separate *Micromitra* (*Paterina*) *bella* and *M.* (*P.*) *labradorica* and the other species mentioned.

In his original description, Billings [1872b, p. 478] says:

> In the specimen above figured there is an aperture in the beak, but in another there is no appearance whatever of a perforation.

In a fine series of *Micromitra* (*Paterina*) *bella* from the Lower Cambrian, south of Emigsville, York County, Pennsylvania, the characteristics of the genus and species are strikingly well shown. In none of the specimens is there in the ventral valve an indication of an apical pedicle opening. The dorsal valve is slightly elevated, and in the half-dozen well-preserved specimens no trace has been observed of any false area or pseudodeltidium; but in *Micromitra* (*Iphidella*) *pannula* the false area is even more clearly defined than in the ventral valve, and the pseudodeltidium is present as a depressed concave covering of more than one-half of the triangular space inside the narrow area on each side. The area on the dorsal valve has also been observed in *M.* (*I.*) *ornatella* (Linnarsson) and *Micromitra* (*Paterina*) *labradorica* (Billings).

Linnarsson [1876, p. 25], in describing *Micromitra* (*Iphidella*) *ornatella*, speaks of the presence of a minute foramen; but, after the study of several finely preserved ventral valves from the *Paradoxides* beds of Andrarum, Sweden, I am led to believe that what he considered to be an apical foramen is a depression in the apex of the shell on the incurved beak which was present in one of the embryonic (nepionic) stages and was subsequently lost. This would involve the crowding out, as it were, of the pedicle posteriorly, the only evidence of its presence in the adult being the narrow, slightly depressed slit at the apex of the valve in some specimens. The pedicle in the adult shell is protruded between the two valves and separated from the scar of the embryonic pedicle slit by the growth of a pseudodeltidium.

The examination of the somewhat closely allied form, *Micromitra* (*Iphidella*) *pannula* (White), shows the presence in some specimens of an apical depression, and its absence in others. In *Micromitra* (*Paterina*) *superba* (Walcott), still more closely approaching the type, *M.* (*P.*) *bella* (Billings), in external appearance, there is no trace of an apical slit. In *Micromitra* (*Paterina*) *crenistria* (Walcott), which is associated with *M.* (*P.*) *superba*, the apex is rounded, while in the somewhat similar but distinct form, *M. pealei* (Walcott), from the Gallatin River valley of Montana, the apical slit is as clearly shown as in *Micromitra* (*Iphidella*) *ornatella* (Linnarsson), but there is no apical foramen.

Hall and Clarke [1892c, p. 97] illustrate a specimen of *Micromitra* (*Paterina*) *bella* showing an apical foramen, but in the description of Pl. IV, fig. 8, the statement is made that the foramen is not altogether distinct in the specimen.

The systematic position of the genus *Micromitra* appears to be in the Atremata of Beecher [1891, p. 354], with possible characters that nearly place it in the Protremata. The presence of an obscure apical furrow in front of the apex of *Micromitra* (*Paterina*) *bella* (Billings), *Micromitra* (*Iphidella*) *ornatella* (Linnarsson), and in some specimens of *Micromitra pealei* (Walcott) tends to support the view that the pedicle was apical in its early stages. We also have to consider the area of what appears to be the dorsal valve of *Micromitra* (*Iphidella*) *pannula*. In this species there is a rather deep convex pseudodeltidium in the conical valve and a clearly defined, depressed pseudodeltidium on the flat valve between the sides of the narrow false area. There is also present on the latter valve a narrow median groove extending from the apex to the posterior margin of the pseudodeltidium; it is similar in appearance to the pedicle groove of the ventral valve of *Obolus* and *Rhinobolus*. This suggests that the flat valve may be the pedicle valve, but the presence of a scar of the embryo pedicle opening on the conical valve is opposed to such an interpretation.

It may be urged that *Micromitra* is a true atrematous genus, the pedicle never having been inclosed and the slit on the ventral valve being only a depression without special significance. This may be so, but the impression it conveys to me is that the slit indicates a pedicle opening which existed near the apex of the ventral valve at an early stage in its growth, but which was subsequently closed, the pedicle continuing to protrude between the valves.

Whiteaves wrote me, under date of July 23, 1896, that with the exception of the specimen which is referred in this monograph to *Micromitra* (*Paterina*) *logani* (see pp. 345 and 350), there were no specimens or electrotypes of the types of *Micromitra* (*Paterina*) *bella* (Billings) in the collections of the Geological Survey of Canada, nor of the closely allied species of the same genus from Topsail Head, mentioned by Billings [1872b, p. 478]. Under the circumstances nothing can be done but to decide from Billings's description and figure [1872b, p. 477] the characters of the species, and refer to the species the form that can best be identified with the description and figure as its typical representative. This appears to be the form from the Lower Cambrian limestone of York County, Pennsylvania. (See pp. 345 and 350, and Pl. II, figs. 1 and 1c.)

Ornamentation of the surface.—One of the most noticeable characters is the surface ornamentation. The type species of *Micromitra* (*M. sculptilis* (Meek), Pl. III, figs. 5, 5a–c) has on some specimens (Pl. III, figs. 5c, 5d) concentric lines similar to those on the less ornamented forms of the genus, as represented by *Micromitra* (*Paterina*) *labradorica* (Billings), and on other specimens a well-defined series of radiating ridges of varying number, width, and strength (Pl. III, figs. 5, 5a, and 5c). It was on account of the surface produced by the concentric lines crossing the radiating ridges that the specific name *sculptilis* was proposed.

Micromitra sculptilis (Meek), the type of group *A* (*Micromitra* Meek), is therefore intermediate in surface characters between the concentrically striated forms of group *B* (*Paterina* Beecher) and the network ornamentation of group *C* (*Iphidella* Walcott), though some examples of the latter group have both the *A* and *C* types of surface on the same shell. The species with the intermediate type of surface may be grouped under the genus *Micromitra*, as follows:

Micromitra alabamaensis (Walcott)	Middle Cambrian.
baydeni Walcott	Do.
nisus (Walcott)	Do.
pealei (Walcott)	Do.
pusilla (Linnarsson)	Do.
scotica Walcott	Lower Cambrian.
sculptilis (Meek)	Middle and Upper Cambrian.
sculptilis endlichi Walcott	Middle Cambrian.
zenobia Walcott	Do.

Micromitra (*Paterina*) *labradorica swantonensis* (Walcott) and *M.* (*P.*) *bella* (Billings) represent the second type (*B*), whose surface is formed of simple concentric striæ and lines of growth. On the basis of surface characters this group is given a subgeneric value, as suggested by Schuchert [1905, p. 329], and the name *Paterina* of Beecher [1891, p. 345] is adopted.[a] The group includes:

Micromitra (Paterina) bella (Billings)	Lower Cambrian.
crenistria (Walcott)	Middle Cambrian.
etheridgei (Tate)	Do.
labradorica (Billings)	Lower Cambrian.
orientalis (Walcott)	Do.
swantonensis (Walcott)	Do.
utahensis (Walcott)	Middle Cambrian.
var. undt	Lower Cambrian.
logani (Walcott)	Middle Cambrian.
major (Walcott)	Lower Cambrian.
phillipsi (Holl)	Upper Cambrian.
prospectensis (Walcott)	Lower Cambrian.
stissingensis (Dwight)	Middle Cambrian.
stissingensis ora Walcott	Do.
stuarti Walcott	Do.
superba (Walcott)	Do.
undosa (Moberg)	Lower Cambrian.
wapta Walcott	Do.
williardi Walcott	Do.

Micromitra (*Iphidella*) *ornatella* (Linnarsson) and *M.* (*I.*) *pannula* (White) represent the third type (*C*), whose surface is formed by the union of the crenulated striæ so as to form a fine network of raised obliquely arranged lines that divide the surface into minute pits that give the impression of finely woven cloth. For the species with this ornamented surface *Iphidella* Walcott [1905a, p. 304] is used in a subgeneric sense. This includes:

Micromitra (Iphidella) louise Walcott	Lower Cambrian.
nyssa Walcott	Middle Cambrian.
ornatella (Linnarsson)	Do.
pannula (White)	Lower and Middle Cambrian.
maladensis (Walcott)	Middle Cambrian.
ophirensis (Walcott)	Do.

Stratigraphic distribution.—The genus ranges from low down in the Lower Cambrian through the Middle Cambrian, and there are two species in the Upper Cambrian.

Of the Lower Cambrian species, *M.* (*I.*) *pannula* (White) passes up into the central portion of the Middle Cambrian in the Marjum limestone of the House Range section, Utah. *Micromitra sculptilis* (Meek) occurs abundantly in the central portion of the Middle Cambrian and has also been found in the Upper Cambrian Dunderberg shale of the Eureka district, Nevada.

Micromitra (*Iphidella*) *pannula ophirensis* (Walcott) has a range of 2,370 feet (722.4 m.) in the House Range section of Utah, occurring in the Middle Cambrian at horizons 220, 2,075, and 2,590 feet (67, 632.5, and 789.4 m.) above the quartzitic sandstones of the Lower Cambrian.

[a] It is therefore impossible to use the type of the preoccupied genus *Iphidea*, *Micromitra* (*Paterina*) *bella*, as the type of this subgenus, as Beecher founded it on "*Obolus labradoricus*." (See p. 344.)

At Ophir, in the Oquirrh Range, it is at the horizon of the Pioche fauna, or near the base of the Middle Cambrian.

The table in the introduction gives a summary of the numbers and the range of the genus by species and varieties. (See p. 99.)

Micromitra alabamaensis (Walcott).

Plate II, figures 5, 5a–c.

Iphidea alabamaensis Walcott, 1897, Proc. U. S. Nat. Mus., vol. 19, pp. 713–714, Pl. LIX, figs. 5, 5a–b. (Discussed somewhat as below as a new species. The specimens represented by figs. 5, 5a–b are redrawn in this monograph Pl. II, figs. 5, 5a, and 5c, respectively.)

In following the Lower Cambrian rocks southward from Vermont, the first type of *Micromitra* met with is *M. stissingensis* (Dwight), which occurs in the Middle Cambrian of Dutchess County, New York. This is fairly well distinguished by its surface character from *Micromitra* (*Paterina*) *labradorica* (Billings) and its variety *swantonensis* (Walcott), but at the next locality to the south in eastern Tennessee, 4 miles (6.4 km.) north of Rogersville, in the Rogersville shale of the Middle Cambrian, was found a form that is practically identical with the northern species or its variety, so far as it is possible to compare specimens preserved in limestone with those preserved in shale. A species of the same general form also occurs in the Middle Cambrian shales of the Cowan Creek section, Cherokee County, Alabama. There is, however, a difference in the surface striæ that distinguishes it from *M.* (*P.*) *labradorica*, *M.* (*P.*) *labradorica swantonensis*, and *M.* (*P.*) *stissingensis*. It is the tendency to crenulation of the striæ in nearly all the specimens that have been examined. This, in extreme cases, goes so far as to approach the surface so characteristic of *Micromitra* (*Iphidella*) *pannula* (White). The form can not well be identified with the closely related *M.* (*P.*) *labradorica* (Billings) or its variety *swantonensis* (Walcott) or *M.* (*P.*) *stissingensis* (Dwight) on account of these peculiar surface characters, and the name *M. alabamaensis* was proposed for it.

In the general form of the valves this species resembles *M.* (*P.*) *labradorica* and *M.* (*P.*) *stissingensis*. So far as known the only specific difference is in the surface character, which allies it with *Micromitra sculptilis* (Meek). The convexity of the valves is unknown, owing to the compression of the shells in the shale, and we have no information of the area or pseudodeltidium. Shell substance corneous.

Formation and locality.—**Upper Cambrian:** (94o) Limestone at base of dolomite, 0.25 mile (0.4 km.) beyond Givens Ford, Cowan Creek, about 8 miles (12.8 km.) southeast of Center, Cherokee County, Alabama.

Middle Cambrian: (90x and 94a) In and attached to the outer surface of siliceous nodules in the Conasauga ("Coosa") shale, Coosa Valley, east of Center; (95a) shales on Spring Creek, near the old tram crossing north of Center road, Cowan Creek valley, southeast of Center; and (94) *shales 0.25 mile (0.4 km.) beyond Steel Ford, Cowan Creek, about 8 miles (12.8 km.) southeast of Center;* all in Cherokee County, Alabama.

(121a) Shales on road leading from southeast of Harlan Knob to Amis post office; (124) shales (Nolichucky?) overlying the limestone which rests on the Rogersville shale, on Big Creek, southeast of Harlan Knob; (123) upper part of Maryville limestone, on Big Creek, southeast of Harlan Knob; and (121) Rogersville shale, road just east of Harlan Knob; all about 4 miles (6.4 km.) northeast of Rogersville [Keith, 1905, p. 4, and areal geology sheet], Hawkins County, Tennessee.

(14a) Sandstone of the Rome formation, along First Creek Gap, 4 miles (6.4 km.) north-northeast of Knoxville [Keith, 1905, areal geology sheet], Knox County, Tennessee.

Micromitra haydeni Walcott.

Text figures 20A–D, page 338.

Micramitra haydeni Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 55–56, Pl. VII, figs. 3 and 3a. (Described and discussed as below as a new species. Figs. 3 and 3a are copied in this monograph as figs. 20A and 20B′.)

Ventral valve subconical, with a minute beak arching slightly over a strong, arched pseudodeltidium which is about one-half as long as the height of the valve. Cardinal slope rounded; a slight angle is indicated by a line where the concentric surface striæ bend inward toward the pseudodeltidium across the narrow area; a sharp angle is formed where the convex pseudodeltidium rises abruptly from the area.

Dorsal valve moderately convex, most elevated at the small umbo just in advance of the marginal minute beak; area very low and narrow, and without trace of pseudodeltidium so far as now known.

Surface marked by fine, concentric, slightly undulating, threadlike striæ and a varying number of irregular, more or less interrupted, narrow, depressed, rounded radiating ridges; these ridges are usually most numerous at the central portions of the valves. The concentric striæ extend across the narrow area and arch over the pseudodeltidium, where they are finer and crowded together so that all the striæ between the apex and the front margin are compressed in about one-half the distance on the pseudodeltidium. The adult ventral valve is about 4.5 mm. in length by 5 mm. in width and 2.5 mm. in height, with a pseudodeltidium 1.3 mm. in length. A dorsal valve 2 mm. in length has a height of about 0.5 mm. at the umbo. The shell is rather thick for a species of this size, and it is built up of several thin layers or lamellæ.

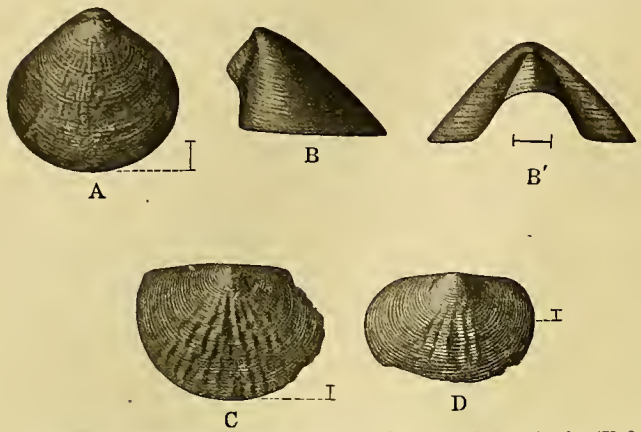

FIGURE 20.—*Micromitra haydeni* Walcott. A, Top view of ventral valve (U. S. Nat. Mus. Cat. No. 51437a). B, B′, Side and back views of a ventral valve (U. S. Nat. Mus. Cat. No. 51437b). C, Exterior of dorsal valve (U. S. Nat. Mus. Cat. No. 51437c). D, Dorsal valve (U. S. Nat. Mus. Cat. No. 51437d).

The specimens represented are from Locality 54s, Middle Cambrian limestones, near Malade, Idaho. Figures 20A and 20B′ are copied from Walcott [1908d, Pl. VII, figs. 3 and 3a]. Figure 20A represents the type specimen.

Observations.—*Micromitra haydeni* differs from the nearest related species, *M. sculptilis* (Meek), in having a strong convex pseudodeltidium, less elevation of the ventral valve, and a thicker shell. *Micromitra haydeni* occurs near the base of the Middle Cambrian and *M. sculptilis* about 2,000 feet (610 m.) higher in the section of the Cambrian rocks of Utah and southern Idaho.

The specific name is given in honor of Dr. F. V. Hayden, geologist and explorer, under whose charge the geology of this region was first studied.

FORMATION AND LOCALITY.—**Middle Cambrian**: (54s) Dark blue-gray Langston limestone [Walcott, 1908f, p. 198], just above the Cambrian quartzitic sandstones, north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

MICROMITRA NISUS (Walcott).

Plate II, figure 10.

Iphidella nisus WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 305. (Described and discussed as below as a new species.)

Ventral valve rather low, with the apex overhanging the posterior margin. Surface marked by very fine lines of growth with still finer bands of striæ between them. About 10 very fine radiating ridges extend from near the apex to the front and lateral margins.

This little shell is represented by a single specimen of the ventral valve. The associated fauna includes fragments of *Olenellus*.

I was at first inclined to refer this shell to *Micromitra sculptilis* (Meek) or *M. pealei* (Walcott), but the overhanging apex and strongly marked surface and the fact that there is an interval of 2,000 miles between the localities of the species led me to separate them. Stratigraphically the two latter species occur in the Middle Cambrian and *M. nisus* in the Lower Cambrian. I do not think the two forms should be included in one species.

FORMATION AND LOCALITY.—**Lower Cambrian**: (2r) In a limestone bowlder in a conglomerate, in a railroad cut 2 miles (3.2 km.) west of Bic railway station, Rimouski County, Quebec, Canada.

Micromitra pealei (Walcott).

Plate III, figures 3, 3a–e.

Iphidea pealei Walcott, 1897, Proc. U. S. Nat. Mus., vol. 19, pp. 712–713, Pl. LIX, figs. 3, 3a–c. (Described and discussed as below as a new species. The two specimens represented by figs. 3, 3a–b, and 3c are redrawn in this monograph, Pl. III, figs. 3, 3a–b, and 3c, respectively.)

Ventral valve subconical, beak slightly incurving over the pseudodeltidium. Cardinal slope flattened to form a narrow false area, which is clearly defined from the curvature of the shell by a slightly elevated threadlike ridge. Pseudodeltidium comparatively narrow, strongly convex, and arched below. The striæ of growth cross the false area and arch over the delthyrium.

Dorsal valve moderately convex, and without any special characteristics to distinguish it from the same valve in *Micromitra* (*Paterina*) *bella* (Billings), *M.* (*P.*) *superba* (Walcott), and *M.* (*P.*) *labradorica* (Billings).

Surface marked by fine concentric striæ and lines of growth that are usually plain, but in some examples are slightly crenulated. In such instances fine radiating lines or striæ are also shown. Shell substance corneous.

In the most perfectly preserved specimens there is a slight furrow or depression near the apex of the ventral valve, but there is no trace of a perforation or apical opening.

This species approaches *M. sculptilis* (Meek) in some examples of the ventral valve. It differs mainly in the narrow pseudodeltidium and the character of the surface markings. It might be considered as a form intermediate between *M.* (*P.*) *bella* (Billings) and *M. sculptilis* (Meek).

The specific name was given in honor of Dr. A. C. Peale, of the Hayden Survey, who collected the type specimen.

Formation and locality.—**Middle Cambrian:** (**4n**) Limestone about 325 feet (99.1 m.) above the unconformable base of the Cambrian in divide at the head of Jackson Creek (locally known as Sheep Creek), a creek flowing into Jackson Lake about 0.5 mile (0.8 km.) south of its northwestern corner, Teton Mountains, Grand Teton quadrangle (U. S. Geol. Survey), Uinta County, Wyoming.

(**159**) Limestones north of West Gallatin (Gallatin) River, Gallatin County; (**302**) limestone east of Gallatin River, above Gallatin, Gallatin County; (**4p**) about 225 feet (68.6 m.) above base of Cambrian in limestones interbedded in Flathead shales of Peale [1893, p. 21], on the north side of West Gallatin (Gallatin) River, 2 miles (3.2 km.) northeast of Logan, Threeforks quadrangle (U. S. Geol. Survey), Gallatin County; (**155a**) *limestone north of East Gallatin River, near Hillsdale, Threeforks quadrangle* (*U. S. Geol. Survey*), *Gallatin County;* (**4h**) about 375 feet (114.3 m.) above base of Cambrian in limestone interbedded in the Flathead shales of Peale [1893, p. 21], 1 mile (1.6 km.) north of the junction of East Gallatin and West Gallatin (Gallatin) rivers, 4 miles (6.4 km.) east-northeast of Logan, Threeforks quadrangle (U. S. Geol. Survey), Gallatin County; (**5f** and **340**) limestone interbedded in the Wolsey shale [Weed, 1900, p. 285], in Meagher County on road to Wolsey, south of the divide at the head of Sawmill Creek, and about 12 miles (19.3 km.) south of Neihart, Little Belt Mountains quadrangle (U. S. Geol. Survey), Cascade County; (**4x**) limestone interbedded in the Wolsey shale [Weed, 1900, p. 285], at the base of a butte in Belt Park, about 6 miles (9.6 km.) northwest of Neihart, Little Belt Mountains quadrangle (U. S. Geol. Survey), Cascade County; and (**9h**) limestone on Beaver Creek, 5 miles (8 km.) north of York, about 8 miles (12.8 km.) north of Canon Ferry, Big Belt Mountains, Fort Logan quadrangle (U. S. Geol. Survey), Meagher County; all in Montana.

(**74**) Sandstone about 300 feet (91.4 m.) above the base of the Tonto group, at the head of Nunkoweap Valley, Grand Canyon of the Colorado, Arizona.

Micromitra pusilla (Linnarsson).

Plate III, figures 2, 2a–c.

Kutorgina cingulata pusilla Linnarsson, 1876, Bihang till K. svensk. Vet.-Akad. Handl., Bd. 3, No. 12, p. 25, Pl. IV, figs. 53 and 54. (Described as below, and discussed in English, as a new variety.)

Kutorgina cingulata Walcott (in part) [not Billings], 1886, Bull. U. S. Geol. Survey No. 30, pp. 102–104. (Specimens now referred to *Micromitra pusilla* were included with the specimens representing *Kutorgina cingulata* when this description was written.)

Kutorgina cingulata pusilla Linnarsson, Matley, 1902, Quart. Jour. Geol. Soc. London, vol. 58, pt. 1, pp. 146–147, figs. 19 and 20, p. 147. (Discussed from a new locality.)

Kutorgina cingulata pusilla Linnarsson, Grönwall, 1902, Danmarks Geol. Undersøgelse, Række 2, No. 13, pp. 40–41. (Discussed in Norwegian.)

Linnarsson [1876, p. 25] gives the following description of the dorsal valve of this species:

Shell small, transversely oval, broadest about the middle. Hinge-line straight, shorter than the width of the shell; cardinal angles rounded. Shell substance apparently corneous. Surface marked with numerous sharply marked, concentric lines of growth. Length, 3 mm.; breadth, 4 mm.

In some material received from Andrarum, Sweden, I found what appear to be the ventral and dorsal valves of this species associated with *Micromitra* (*Iphidella*) *ornatella* (Linnarsson) and *Acrotreta socialis* von Seebach. The ventral valve shows a well-defined false area on each side of a triangular opening. The broken edge of the pseudodeltidium is shown on the side of the upper end of the fissure, but its form and depth can not be determined.

This species is related to *Micromitra* (*Paterina*) *labradorica* (Billings), differing from it in having a less elevated ventral valve, radiating ridges on the surface, and being more uniformly smaller in size. It is evidently a rare form, as only three specimens were met with in breaking up a large quantity of rock.

Formation and locality.—**Middle Cambrian**: (**8w**) Limestones of the *Paradoxides forchhammeri* zone, at Andrarum, 20 miles (32.2 km.) northwest of Simrishamn, Province of Christianstad; (**320f**) limestone at Andrarum, 20 miles (32.2 km.) northwest of Simrishamn, Province of Christianstad; and (**320u** [Linnarsson, 1876, p. 25]) strata with *Agnostus lævigatus* at Östra Rynninge, in Nerike; all in Sweden.

(**16h**) *Limestones of the Paradoxides forchhammeri zone at Borregaard;* and (**16j**) limestones of the *Paradoxides forchhammeri* zone at Laesaå; both on Bornholm Island, Denmark.

Matley [1902, p. 146] has identified this species from the following locality:[a]

Upper Cambrian: (**304b**) Lower part of the "White Leaved Oak" shales (the zone of *Polyphyma*), Malvern Hills, between Herefordshire and Worcestershire, England.

Micromitra scotica n. sp.

Text figures 21A–C.

Ventral valve moderately convex, transverse in outline. Beak almost apical, slightly in advance of the posterior margin, which is nearly straight. Cardinal slopes flattened to form a false area that is almost as wide as the greatest width of the shell. Pseudodeltidium narrow and arching somewhat above the plane of the margin of the shell.

Dorsal valves unknown.

Surface marked by rather coarse concentric striæ and radiating ridges. The concentric striæ cross the false area and the pseudodeltidium.

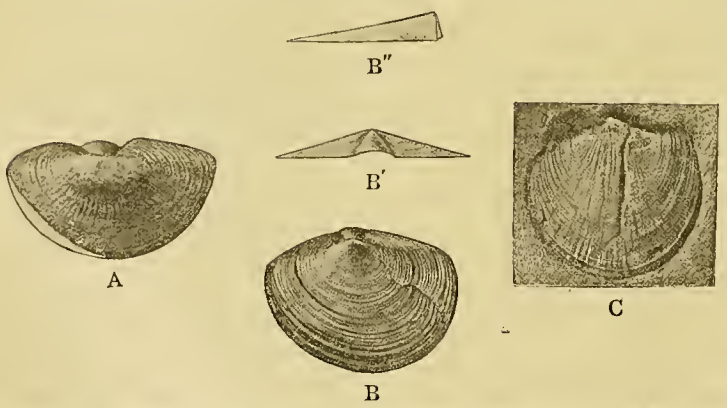

Figure 21.—*Micromitra scotica* n. sp. A, Type specimen, a ventral valve, ×4, from Locality **316d**, Lower Cambrian shale on Meall á Ghiubhais, Ross-shire, Scotland (U. S. Nat. Mus. Cat. No. 58310). B, B′, B″, Top, side, and back views of a ventral valve, ×5, from Locality **316d**, Lower Cambrian shale on Meall á Ghiubhais, Ross-shire, Scotland (Geol. Survey Scotland, specimen No. M2646e). C, Top view of a crushed ventral valve, ×2.5, from Locality **316d**, on Meall á Ghiubhais, Ross-shire, Scotland (Geol. Survey Scotland, specimen No. M4178d).

Observations.—This species appears to be most closely related to *Micromitra pusilla* (Linnarsson), but is to be distinguished from that species by reason of its long pseudodeltidium and the fact that the beak does not overhang the false area. The latter species occurs in the Middle Cambrian and *Micromitra scotica* is associated with *Olenellus* in Scotland.

Formation and locality.—**Lower Cambrian**: (**316d**)[b] Localities M2646e, M2647e, and M4178d of the Geological Survey of Scotland, about 500 feet (152.5 m.) above the provisional base of the Cambrian and 75 feet (23 m.) below what is believed to be the top of the Lower Cambrian in the shales forming 5 and 6 of the section given by Peach and Horne [1907, p. 414], in a small burn on the north slope of Meall á Ghiubhais, 4 miles (6.4 km.) west-northwest of the Kinlochewe Hotel, Loch Maree, Ross-shire, Scotland.

[a] Groom [1902, p. 109] describes the locality and cites a list of the associated species.

[b] Specimens from this locality are also included in the collections of the United States National Museum.

Micromitra sculptilis (Meek).

Plate III, figures 5, 5a–e.

Iphidea (??) sculptilis Meek, 1873, Sixth Ann. Rept. U. S. Geol. and Geog. Survey Terr. for 1872, p. 479. (Described and discussed as a new species, and the generic name "*Micromitra*" proposed in case the species should prove to belong to a new genus.)

Kutorgina minutissima Hall and Whitfield, 1877, U. S. Geol. Expl. 40th Par., vol. 4, pt. 2, pp. 207–208, Pl. I, figs. 11 and 12. (Described and discussed as a new species. The specimens represented by figs. 11 and 12 are redrawn in this monograph, Pl. III, figs. 5b and 5c, respectively.)

Kutorgina sculptilis (Meek), Walcott, 1884, Mon. U. S. Geol. Survey, vol. 8, p. 20, Pl. I, figs. 7, 7a–b, Pl. IX, fig. 7. (The three specimens represented in Pl. I, figs. 7 and 7a, Pl. I, fig. 7b, and Pl. IX, fig. 7, are redrawn in this monograph, Pl. III, figs.5, 5b, and 5c, respectively.)

Iphidea sculptilis Meek, Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 235. (Merely goes back to original generic reference.)

Iphidea sculptilis Meek, Walcott, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, pp. 447–448, Pl. LX, figs. 5, 5a–c. (Discussed. The specimen represented by figs. 5, 5a–c is redrawn in this monograph, Pl. III, fig. 5a.)

Iphidella sculptilis (Meek), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 308. (Merely changes generic reference.)

In the description of *Iphidea (??) sculptilis*, Meek [1873, p. 479] decided that as the shell had a very narrow, slightly flattened margin on each side, representing a false area, and that as there seemed to be a wide-open triangular foramen, it could be referred to the genus *Acrotreta* or the genus *Iphidea*. He was not positive that there was not a permanent pseudodeltidium present, but assuming the absence of that structure, and thinking it probable that when all the characters of the shell were known it would be found to belong to a different genus, either of the Brachiopoda or of some other group, he proposed for the genus the name "*Micromitra*."

A study of the specimens of *M. sculptilis* collected from the same horizon, at a point not far distant from the original locality, shows the presence of a false area and a pseudodeltidium of the same type as that of *Micromitra* (*Paterina*) *bella* (Billings). There is, however, a difference in the two forms that is considered of subgeneric value. The surface of *M.* (*P.*) *bella* is covered with fine concentric striæ and the surface of *Micromitra sculptilis* is marked by very fine, sharp, elevated concentric lines that coalesce or bifurcate irregularly, imparting a peculiarly interrupted wavy appearance that is highly characteristic. The variation in the surface character is continued still further in *Micromitra* (*Iphidella*) *pannula* (White), in which the surface is divided into minute porelike pits by a very fine network of oblique raised lines. Under the lens the surface resembles that of finely woven cloth.

The most nearly related species is *Micromitra haydeni* Walcott, which has a similar surface, but the latter has a large pseudodeltidium on the ventral valve, and that valve is more depressed than in *M. sculptilis*.

A fragmentary ventral valve from 2,500 feet (762 m.) up in the Middle Cambrian series of the northern Wasatch Mountains appears to be a form somewhat intermediate between *Micromitra* (*Paterina*) *crenistria* (Walcott) and *M. sculptilis*. It has the surface of the latter except that the radiating ribs are very faint. It occurs in the Blacksmith Fork section, east of Hyrum, Utah.

Formation and locality.—**Upper Cambrian:** (61) Limestone in the Dunderberg shale [Walcott, 1908f, p. 184], a little south of the Hamburg mine; and (62) limestone in the Dunderberg shale [Walcott, 1908, p. 184], in a canyon immediately north of Adams Hill; both in the Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

Middle Cambrian: (302) *Limestone cast of Gallatin River, above Gallatin;* and (302a and 302c) limestones at several places on the south side of the Gallatin Valley; both in Gallatin County, Montana.

(302b) Limestones near Crowfoot Ridge, Gallatin quadrangle (U. S. Geol. Survey), Yellowstone National Park, Wyoming.

(55n) About 1,850 feet (564 m.) above the Brigham quartzite and 2,350 feet (716 m.) below the Upper Cambrian in the limestones forming 2g of the Bloomington formation [Walcott, 1908f, p. 195], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

(8i) Shales believed to be referable to the lower portion of the Marjum limestone [Walcott, 1908f, p. 180], found about 0.5 mile (0.8 km.) east of Antelope Springs; (3x) about 2,200 feet (670.6 m.) above the Lower Cambrian and 2,200 feet (670.6 m.) below the Upper Cambrian in the limestones forming 1d of the Marjum limestone [Walcott, 1908f, p. 180], 2.5 miles (4 km.) east of Antelope Springs in ridge east of Wheeler Amphitheater; and (10y) about 2,900

feet (884 m.) above the Lower Cambrian and 1,500 feet (457.2 m.) below the Upper Cambrian in the central part of the bed forming 1a of the Marjum limestone [Walcott, 1908f, p. 179], about one mile (1.6 km.) south-southwest of Marjum Pass; all in the House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah.

(11s) Shales just above Simpson Spring, about 20 miles (32.2 km.) west-southwest of Vernon, on the stage road from Vernon to Fish Spring, Tooele County, Utah.

(10w) Shaly limestones about 5 miles (8 km.) northeast of Osceola, on the east side of the Snake Range, White Pine County; and (58) shaly limestones in upper beds of Secret Canyon shale, either in New York or Secret Canyon, Eureka district [Hague, 1892, Atlas], Eureka County; both in Nevada.

Specimens that are compared with *Micromitra sculptilis* occur at the following locality:

Middle Cambrian: (54i) About 2,950 feet (899.2 m.) above the Brigham quartzite and 1,225 feet (373.4 m.) below the Upper Cambrian in the limestone forming 1e of the Bloomington formation [Walcott, 1908f, p. 194], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

Micromitra sculptilis endlichi Walcott.

Text figure 22.

Micromitra sculptilis endlichi Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 56. (Characterized as below as a new variety.)

This form is represented by a single specimen of a ventral valve. The surface is similar to that of *Micromitra sculptilis* (Meek), but the valve is more elongate, less elevated, and larger (5 mm. in diameter) than the specimens of the latter from the type locality.

The varietal name is given for Mr. F. M. Endlich of the Hayden Survey.

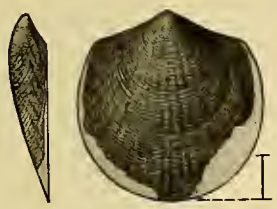

Figure 22.—*Micromitra sculptilis endlichi* Walcott. A, A', Top and side views of the type specimen, a ventral valve from Locality 80, Upper Cambrian limestones, 2 miles (3.2 km.) north of Aurum, White Pine County, Nevada (U. S. Nat. Mus. Cat. No. 51498).

Formation and locality.—**Upper Cambrian:** (80) Limestone 2 miles (3.2 km.) north of Aurum, Schell Creek Range, White Pine County, Nevada.

Micromitra zenobia n. sp.

Text figure 23.

Most of the specimens of this species are flattened in the shale, but both valves appear to have been moderately and nearly equally convex. The beak of the ventral valve is slightly in advance of the posterior margin and incurves slightly over a well-defined cardinal slope which is nearly straight and almost as wide as the greatest diameter of the shell. The pseudodeltidium is moderately convex and apparently extends about half the distance from the beak to the posterior margin.

Growth lines are fairly coarse and regular. In the ventral valve they bend abruptly at the cardinal slope, on which they are very fine and very irregular. In other words, the cardinal slope is well defined and is covered with an irregular confusion of minute ridges which seem to bear little relation to the concentric ridges on the surface of the shell. This pattern can not be seen on the pseudodeltidium.

In some of the adult shells from the type locality (35k) a faint radial crenulation can be seen near the apex. Fragments of limestone (Locality 57c) contain many small shells, probably the young, with radial folds and a crenulation of the concentric striæ similar to that in *Micromitra sculptilis*. The crenulations have been observed in one perfectly preserved adult specimen. The specimens from the limestone may be distinct.

Figure 23.—*Micromitra zenobia* n. sp. Top view of type specimen, a ventral valve from Locality **35k**, Middle Cambrian Stephen formation 1 mile (1.6 km.) northeast of Burgess Pass, above Field, British Columbia (U. S. Nat. Mus. Cat. No. 58311).

Formation and locality.—**Middle Cambrian:** (35k) *Burgess shale member of the Stephen formation, west slope of ridge between Mount Field and Wapta Peak, 1 mile (1.6 km.) northeast of Burgess Pass, above Field;* and (58 1) about 1,830 feet (557.8 m.) above the Lower Cambrian in the limestone forming 3b of the Stephen formation [Walcott, 1908c, p. 238 (7)], on the east side of Mount Stephen about 3,000 feet (914.4 m.) above the Canadian Pacific Railway track 3.5 miles (5.6 km.) east of Field; both in British Columbia.

(57c) About 2,500 feet (762 m.) above the Lower Cambrian and 2,475 feet (754 m.) below the Upper Cambrian in the limestone forming 1 of the Stephen formation [Walcott, 1908f, p. 209]; and (58z) about 1,875 feet (572 m.) above the Lower Cambrian and 3,100 feet (945 m.) below the Upper Cambrian in the limestone forming 2b of the Stephen formation [Walcott, 1908f, p. 211]; both on Mount Bosworth, north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide between British Columbia and Alberta, Canada.

MICROMITRA sp. undt. (Walcott).

Plate III, figure 7.

Iphidea sp. undet., WALCOTT, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, p. 449, Pl. LX, fig. 6. (Described and discussed as below as an undetermined species. The specimen represented by fig. 6 is redrawn in this monograph, Pl. III, fig. 7.)

Iphidella sp. undt., WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 305. (Description and discussion copied from preceding reference.)

Dorsal valve semicircular, slightly convex. Hinge line somewhat shorter than the width of the shell below; nearly straight, the rostral angle about 180°. Beak small, not elevated. Surface ornamented by extremely fine, radiating, and undulating concentric striæ that can be seen in detail only with a strong magnifying glass. Shell substance horny.

This form is associated with *Micromitra sculptilis* (Meek) and, judging from external characters, is closely related to it. The surface ornamentation is of the same character, and, in the absence of the ventral valve, it is difficult to distinguish any specific characters on which to base a new species, although the shell is much larger than that of *M. sculptilis*.

FORMATION AND LOCALITY.—**Middle Cambrian**: (302b) Limestones near Crowfoot Ridge, Gallatin quadrangle (U. S. Geol. Survey), Yellowstone National Park, Wyoming.

PATERINA Beecher,[a] subgenus of MICROMITRA.

[Pater, father.]

Kutorgina DALL (in part) [not BILLINGS], 1877, Bull. U. S. Nat. Mus. No. 8, pp. 40–41. (Includes reference to specimens now referred to *Micromitra* (*Paterina*).)

Kutorgina WALCOTT (in part) [not BILLINGS], 1886, Bull. U. S. Geol. Survey No. 30, pp. 101–102. (Genus *Kutorgina* described, but description also includes reference to specimens now referred to *Micromitra*, *Micromitra* (*Paterina*), and *Micromitra* (*Iphidella*).)

Paterina BEECHER, 1891, Am. Jour. Sci., 3d ser., vol. 41, p. 345, and footnote. (Gives reasons for proposing *Paterina* as a new genus.)

Paterina Beecher, HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 247. (Described.)

Iphidea Billings, HALL and CLARKE, 1892, idem, p. 249. (Described and accompanied by figures of specimens referred to the subgenus *Paterina*.)

Paterina Beecher, HALL and CLARKE, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, p. 563. (Copy of Hall and Clarke, 1892a, p. 247.)

Iphidea Billings, HALL and CLARKE, 1892, idem, p. 565. (Copy of Hall and Clarke, 1892a, p. 249.)

Kutorgina HALL and CLARKE (in part) [not BILLINGS], 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 90–94. (Copies Walcott's description [1886, pp. 101–102] and discusses genus, but description and discussion also include reference to specimens now referred to *Micromitra*, *Micromitra* (*Paterina*), *Micromitra* (*Iphidella*), *Protorthis*, and *Billingsella*.)

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[a] The synonymy for this subgenus does not give a complete record of the various genera under which the species now included in *Paterina* were formerly placed; it includes only those references in which the subgenus is discussed or described. For the sake of completing the record the remaining mere generic references are here listed:

Obolus Billings [1861b, p. 6; 1861c, p. 946; 1862e, p. 218; 1863, p. 284].
Obolella Holl [1865, p. 102].
Obolella? Davidson [1866, p. 62].
Kutorgina Davidson [1868, p. 312; 1871, p. 342].
Obolella Phillips [1871, p. 68].
Iphidea Billings [1872b, p. 477; 1874, p. 76].
Obolellus? Roemer [1876, Pl. II, figs. 6a–d].
Obolella Dall [1877, p. 41].
Iphidea Billings [1882, p. 13].
Kutorgina Davidson [1883, p. 212].
Kutorgina Walcott [1884h, p. 19].
Iphidea Walcott [1886b, p. 100].
Iphidea Oehlert [1887, p. 1270].
Kutorgina Dwight [1889, p. 145].
Kutorgina Walcott [1890, p. 36].
Kutorgina Dwight [1891, p. 105].
Iphidea Walcott [1891a, p. 608].
Kutorgina Walcott [1891a, p. 609].
Kutorgina Moberg [1892b, p. 112].
Platyceras Tate [1892, p. 184].
Iphidea Hall and Clarke [1892c, Pl. IV, figs. 6 and 7].
Iphidea Grabau [1900, p. 617].
Kutorgina Matley [1902, p. 145].
Micromitra Clark and Mathews [1906, p. 252].

Iphidea Billings, Walcott (in part), 1897, Proc. U. S. Nat. Mus., vol. 19, pp. 707–711. (Discussed. The genus as discussed includes species now referred to *Micromitra*, *Micromitra* (*Paterina*), and *Micromitra* (*Iphidella*).)

Paterina Beecher, Walcott, 1897, idem, p. 708. (Discussed as synonym of *Iphidea*.)

Iphidea Billings, Schuchert (in part), 1897, Bull. U. S. Geol. Survey No. 87, p. 233. (Merely refers *Micromitra* and *Paterina* to *Iphidea*.)

Iphidella Walcott (in part), 1905, Proc. U. S. Nat. Mus., vol. 28, p. 304. (Merely proposed to replace *Iphidea*, but includes reference to specimens belonging with *Micromitra*, *Micromitra* (*Paterina*), and *Micromitra* (*Iphidella*).)

Iphidea Billings, Grabau and Shimer (in part), 1907, North American Index Fossils, vol. 1, p. 201. (Described, and includes species referred to each of the subgenera *Paterina* and *Iphidella*.)

Micromitra (*Paterina*) (Beecher), Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 143. (Classification of subgenus.)

All of the species of *Micromitra* with plain concentric striæ on the outer surface are grouped under *Paterina* as a subgenus. Beecher [1891, p. 345] quoted "*Obolus labradoricus* Billings" as the type of his genus *Paterina*, supposing that the species represented the simplest form of brachiopod known. The genus was subsequently shown [Walcott, 1897b, p. 707] to have been previously described [Meek, 1873, p. 479] under a different name, *Micromitra* (*Iphidea* being preoccupied [Schuchert, 1905, p. 329]), but as it appears necessary to group the shells of which *Micromitra* (*Paterina*) *labradorica* (Billings) is a typical example under a subgenus, I have adopted *Paterina* as the name for it.

Type.—*Kutorgina labradorica swantonensis* Walcott [1890, p. 36].

Beecher studied the specimens of the variety *Micromitra* (*Paterina*) *labradorica swantonensis* (Walcott) which were in my laboratory in the United States National Museum and did not at the time have the specimens of "*Obolus labradoricus*" from the St. Lawrence Valley. He mistook the duplicate specimens of the variety for the species, and it was from the material he examined that the area of the ventral valve was subsequently worked out, as shown on Plate II, figures 3d, 3e, and 3f.

A list of the species referred to *Paterina* has been given under the genus *Micromitra* (p. 336).

Micromitra (Paterina) bella (Billings).

Plate II, figures 1, 1a–c.

Iphidea bella Billings, 1872, Canadian Naturalist, 2d ser., vol. 6, No. 4, pp. 477–478, fig. 13. (Described and discussed as a new species; see p. 345, for copy. Fig. 13 is reproduced in this monograph, Pl. II, fig. 1c.)

Iphidea bella Billings, 1874, Geol. Survey Canada, Paleozoic Fossils, vol. 2, pt. 1, p. 76, fig. 44. (Description and figure copied from preceding reference.)

Iphidea bella Billings, 1882, Geol. Survey Newfoundland, Rept. Progress for 1881, Appendix, p. 13, fig. No. 8. (A copy of the preceding reference.)

Iphidea bella Billings, Walcott, 1886, Bull. U. S. Geol. Survey No. 30, p. 100, Pl. VII, fig. 4. (Copies the original description, Billings, 1872b, pp. 477–478, and discusses species. Fig. 4 is copied from Billings, 1872b, fig. 13, p. 477.)

Iphidea bella Billings, Oehlert, 1887, Manuel de conchyliologie, by Fischer, p. 1270, fig. 1026. (Mentioned in French. Fig. 1026 is copied from Billings, 1872b, fig. 13, p. 477.)

Iphidea bella Billings, Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 608, Pl. LXVII, fig. 6. (Mentioned. Fig. 6 is copied from Billings, 1872b, fig. 13, p. 477.)

Not *Iphidea bella* Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York, for 1891, p. 249, Pl. IV, figs. 4 and 5. (Mentioned. Referred in this monograph to *Micromitra* (*Paterina*) *labradorica swantonensis*.)

Iphidea bella Billings, Hall and Clarke (in part), 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 98, fig. 54, not Pl. IV, figs. 8 and 9. (Mentioned in the text. Fig. 54 is copied from Billings, 1872b, fig. 13, p. 477. The specimens represented by figs. 8 and 9 are referred in this monograph to *Micromitra* (*Paterina*) *labradorica swantonensis*.)

Iphidea bella Billings?, Grabau, 1900, Occas. Papers Boston Soc. Nat. Hist., No. 4, vol. 1, pt. 3, pp. 617–618, Pl. XXXI, fig. 2. (Described and discussed.)

Micromitra bella (Billings), Clark and Mathews, 1906, Maryland Geol. Survey, vol. 6, pt. 1, p. 252, Pl. XVI, fig. 15. (No text reference. Fig. 15 is copied from Walcott, 1886, Pl. VII, fig. 4.)

Iphidea bella Billings, Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 201, fig. 234h, p. 199. (Described. Fig. 234h is copied from Billings, 1872b, fig. 13, p. 477.)

The shell described and illustrated by Billings [1872b, pp. 477–478] had a large false area and a convex pseudodeltidium, the width of which at the hinge line was stated to be nearly one-third the whole width of the shell.

I received from Whiteaves what was supposed to be the type specimen of the ventral valve, from Trois Pistoles, but I find that it does not belong to the species described by Billings [1872b, p. 477]. The area is strongly marked, but the pseudodeltidium in the specimen before me is very short, not over one-fifth the height of the deltidial area. In this respect it resembles the pseudodeltidium of *Micromitra* (*Paterina*) *crenistria* (Walcott). It is described in this monograph as *M.* (*P.*) *logani* (Walcott). Under date of July 23, 1896, Professor Whiteaves wrote that there were no other specimens or electrotypes of the types of *M.* (*P.*) *bella* (Billings) in the collections of the Geological Survey of Canada, nor of the closely allied species of the same genus from Topsail Head, mentioned by Billings [1872b, p. 478]. (See pp. 335 and 350, and Pl. II, figs. 1 and 1c.)

Billings [1872b, pp. 477–478] describes the genus and species as follows:

The ventral ? valve of *I. bella* is conical, strongly elevated at the beak, hinge line nearly straight, posterior angles narrowly rounded, sides and front nearly uniformly rounded, forming rather more than a semicircle. Posterior side with a large false area and a convex pseudodeltidium, the width of which at the hinge line is nearly one-third the whole width of the shell. The dorsal valve is semicircular, moderately convex, most elevated at the beak. The hinge line appears to be straight. The form and structure of the posterior side (such as the area, foramen, deltidium, etc.) can not be made out from the specimen, owing to its imperfection. The surface is covered with fine concentric striæ, which in the ventral? valve are continued around on the area. Of these striæ there appear to be from fifteen to twenty in the width of one line, their size varying somewhat in different parts of the specimen. There are also a few obscure radiating striæ. Width of ventral valve, seven lines; length, five lines; height, two lines.

Very little is to be added to this description from a study of the material from the north side of the Straits of Belleisle and from Pennsylvania, except that the examination of a number of specimens has revealed the fact that there is no true perforation in the beak. Billings states that in the specimen described by him there is an aperture in the beak, but in another there is no appearance of one. I observed a narrow furrow near the apex of the beak in a specimen from L'Anse au Loup, Labrador, but there was no aperture through the shell. Several other specimens afford no traces of even a slight slit in front of the beak. The presence of this depression or furrow is mentioned, and its character set forth in the description of the genus *Micromitra* (p. 335).

FORMATION AND LOCALITY.—**Lower Cambrian:** (**2n**) *Limestone bowlders in conglomerate, along the shore of the St. Lawrence, near Trois Pistoles, Temiscouata County;* and (**2o**) limestone bowlders in conglomerate on shore at east entrance to harbor at Bic, Rimouski County; both in Quebec, Canada.

(**314e** [Billings, 1872b, p. 478]) Limestone at Topsail Head, Conception Bay, Newfoundland.

(**392a**) Limestone [Walcott, 1891b, p. 254] at L'Anse au Loup, on the north shore of the Straits of Belleisle, Labrador.

(**326g** [Grabau, 1900, p. 617]) Limestones at East Point, Nahant, Essex County, Massachusetts.

(**49**) Sandstone on Codorus Creek, 0.125 mile (0.2 km.) below Meyer's mill, near Emigsville, York County; (**346a**) limestones in Landis Valley, Lancaster County; and (**49w**) limestones in railroad cut 0.25 mile (0.4 km.) south of Emigsville, York County; all in Pennsylvania.

(**25**) Sandstone just above Parker's quarry, near Georgia, Franklin County, Vermont.

MICROMITRA (PATERINA) CRENISTRIA (Walcott).

Plate III, figures 4, 4a–b.

Iphidea crenistria WALCOTT, 1897, Proc. U. S. Nat. Mus., vol. 19, p. 713, Pl. LIX, figs. 4, 4a–b. (Described and discussed essentially as below as a new species. The specimen represented by figs. 4, 4a–b is redrawn in this monograph, Pl. III, figs. 4, 4a–b.)

Ventral valve subconical, beak nearly apical, curving slightly over to the pseudodeltidium. False area very narrow, separated from the curvature of the shell by being turned somewhat abruptly backward. Pseudodeltidium comparatively broad, but decidedly short as compared with that of *Micromitra* (*Paterina*) *bella* (Billings) or *M.* (*P.*) *superba* (Walcott). It is more the type of that of *M.* (*P.*) *labradorica* (Billings). It is strongly arched, leaving a broad, high space between it and the plane of the shell.

Dorsal valve unknown. Surface of ventral valve marked by very fine, slightly crenulated striæ that are so crowded on the false area that they are nearly lost, and only one or two varices of growth and a few striæ are shown on the pseudodeltidium. No traces of an apical opening have been seen. On some shells a faint furrow is seen on the apex.

This species is clearly distinguished from other described forms of the subgenus by its highly arched pseudodeltidium and crenulated surface striæ.

An imperfect ventral valve from the upper portion of the Secret Canyon shale of the Eureka district section, Nevada, has somewhat coarser striæ than this species, but otherwise it appears to be the same. Specimens from near Schellbourne, Nevada, appear to be identical with the Grand Canyon form. A single imperfect ventral valve, from the Orr formation, 930 feet above the base of the Upper Cambrian, in the House Range section of Utah, is very much like the specimen from the Secret Canyon shale of Nevada and is tentatively placed with it under this species. The Grand Canyon, Utah, and Nevada shells appear to be descendants of *M. (P.) labradorica* of the Lower Cambrian and its varieties in the lower portion of the Middle Cambrian of the Cordilleran region.

This form owes its specific name to the finely crenulated striæ with which its outer surface is characterized.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**313**) Limestone 0.75 mile (1.2 km.) east-northeast of McGill post office, White Pine County, Nevada.

Middle Cambrian: (**75**) "Tonto" sandstone, near the water's edge, at the mouth of Kanab Canyon, where it enters the Grand Canyon of the Colorado; (**73b**) sandstone in upper part of Tonto group, lower portion of Kwagunt Valley, Grand Canyon of the Colorado; and (**74**) *sandstone about 300 feet (91.4 m.) above the base of the Tonto group, at the head of Nunkoweap Valley, Grand Canyon of the Colorado;* all in Arizona.

(**313b**) Limestone 3 miles (4.8 km.) north-northeast of Schellbourne, Schell Creek Range, White Pine County, Nevada.

(**13b**) Sandstones of the Rome formation, northeast of Rhea Springs [Hayes, 1894, areal geology sheet], Roane County, Tennessee.

Specimens somewhat doubtfully referred to this species occur at the following localities:

Upper Cambrian: (**30j**) About 950 feet (289.6 m.) above the Middle Cambrian and 2,450 feet (746.8 m.) below the top of the Upper Cambrian near the base of the arenaceous shales and limestone forming 1e of the Orr formation [Walcott, 1908f, p. 176], on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah.

Middle Cambrian: (**58**) Shaly limestones in the upper beds of the Secret Canyon shale, east side of New York and Secret canyons, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

MICROMITRA (PATERINA) ETHERIDGEI (Tate).

Plate III, figures 10, 10a–c.

Platyceras etheridgei TATE, 1892, Trans. Roy. Soc. South Australia for 1892, vol. 15, pt. 2, p. 184, Pl. II, figs. 7a–c. (Described and discussed as a new species. The two specimens represented by figs. 7a–c are redrawn in this monograph, Pl. III, figs. 10, 10a–b.)

The original description by Tate follows:

Shell small, broadly conical; apex obtuse, posterior, recurved, but not spiral, usually protruding beyond the posterior margin; aperture roundly oval, but irregular in outline, subtruncated and narrowed posteriorly. Surface ornamented with rather thick subimbricating concentric folds of growth, and curved beneath the apex coincidently with the posterior margin; faintly radially wrinkled.

This very common species exhibits considerable variability in the outline of the aperture, and the amount of backward projection of the apex. The shells seem to have lived on irregular surfaces, and in some instances at least upon trilobites. The proportionate measures of the basal diameter and height are as 4 to 3; the longest diameter observed is 6 mills.

The examination of the type specimen of this species shows that the shell substance is corneous, that there is a true false area, and that the species is closely related to *Micromitra (Paterina) superba* (Walcott). All of the specimens in the collection are ventral valves, and these differ considerably in elevation, apparently owing to the upward arching of the posterior margin beneath the false area. This characteristic distinguishes the species from *M. (P.) superba* and allied forms.

The specific name was given in honor of Dr. R. Etheridge, jr.

FORMATION AND LOCALITY.—**Middle ? Cambrian:** (**315** [Tate, 1892, p. 184]) Limestone at Curramulka, Yorke Peninsula, South Australia.

Micromitra (Paterina) labradorica (Billings).

Plate II, figures 2, 2a–f.

Obolus labradoricus Billings, 1861, Geol. Survey Canada, Paleozoic Fossils, vol. 1, p. 6, fig. 6. (Described as a new species. The specimen represented by fig. 6 is redrawn in this monograph, Pl. II, fig. 2.)

Obolus labradoricus Billings, 1861, Report on the Geology of Vermont, vol. 2, p. 946, fig. 345. (Copy of preceding reference.)

Obolus labradoricus Billings, 1862, Report on the Economic Geology of Vermont, by Hager, p. 218, fig. 345. (Copy of preceding reference.)

Obolus labradoricus Billings, 1863, Geol. Survey Canada, Fifteenth Rept. Progress, p. 284, fig. 291. (No text reference. Fig. 291 is copied from Billings, 1861b, fig. 6, p. 6.)

Iphidea labradorica Billings, 1872, Canadian Naturalist, 2d ser., vol. 6, No. 4, p. 478. (Merely changes generic reference.)

Iphidea labradorica Billings, 1874, Geol. Survey Canada, Paleozoic Fossils, vol. 2, pt. 1, p. 76. (Copy of preceding reference.)

Kutorgina labradorica (Billings), Walcott (in part), 1886, Bull. U. S. Geol. Survey No. 30, p. 104, not Pl. IX, figs. 2, 2a–b. (Original description, Billings, 1861b, p. 6, copied and species discussed. The specimens figured, however, belong with *Micromitra (Paterina) labradorica swantonensis*.)

Not *Paterina labradorica* Beecher, 1891, Am. Jour. Sci., 3d ser., vol. 41, footnote, pp. 345–346, Pl. XVII, figs. 1 and 2. (The specimens here referred to belong with *Micromitra (Paterina) labradorica swantonensis*.)

Kutorgina labradorica (Billings), Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 609, Pl. LXIX, figs. 3, 3a–b. (Mentions new locality. The specimens represented by figs. 3, 3a–b are redrawn in this monograph, Pl. II, figs. 2d, 2c, and 2a, respectively.)

Not *Paterina labradorica* Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York, for 1891, p. 247, fig. 258. (Genus *Paterina* described. Fig. 258 is copied from Walcott, 1886b, Pl. IX, figs. 2b and 2a, but the specimens belong with *Micromitra (Paterina) labradorica swantonensis*.)

Iphidea labradorica (Billings), Schuchert (in part), 1897, Bull. U. S. Geol. Survey No. 87, p. 234. (Accepts Billings's reference of "*Obolus labradoricus*" to *Iphidea*, but includes reference to specimens of *Micromitra (Paterina) labradorica swantonensis*.)

Iphidella labradorica Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 307. (Merely changes generic reference.)

Ventral valve depressed, conical; the beak high and arched over the narrow area. Cardinal slopes flattened so as to form a narrow false area, which is clearly defined from the curvature of the shell by a sharp angle; pseudodeltidium unknown.

Dorsal valve moderately convex, transverse, the hinge line being usually a little shorter than the greatest width of the shell below. Beak small, slightly incurving over the pseudodeltidium. In some specimens there is a broad low mesial sinus, while in others this feature is scarcely discernible. Cardinal slope nearly vertical, forming a clearly defined narrow area, broken at the center by a broad pseudodeltidium, the center of which is marked by a rather broad, slight groove. The pseudodeltidium is well shown in two specimens, but the details of its characters are not so well exhibited as in specimens of the dorsal valve of *Micromitra (Iphidella) pannula* (White). Striæ of growth cross the false area and pseudodeltidium.

The surface is marked by rather fine concentric striæ that are quite regular near the apex of the shell, but less so outward toward the margin, as shown by the type specimens that Whiteaves kindly sent on to me for study. These also show fine, radiating striæ that cross the concentric striæ and lines of growth, giving to the striæ a slightly crenulated appearance somewhat similar to that of *Micromitra (Paterina) prospectensis* (Walcott). Where the shell is exfoliated, radiating striæ are distinctly shown on the cast of the interior. On specimens from the limestone carrying *Olenellus*, etc., at Topsail Head, Conception Bay, Newfoundland, the surface striæ are less distinctly marked and the shells are smaller, but there appears to be no specific difference between those from the Straits of Belleisle. Shell substance corneous.

With a type specimen from L'Anse au Loup before me for comparison with the form from the Lower Cambrian limestone east of Swanton, Vermont, I am still inclined to distinguish the latter as the variety *swantonensis*. The striæ of the Swanton shells are usually finer and more regular and the valves less transverse in proportion to the length. It is quite probable that these differences would largely disappear on the comparison of a larger series of specimens from the type locality, as there is a considerable range of variation among those from east of Swanton and those from Topsail Head.

In the Hanford Brook section of New Brunswick I found very good illustrations of this species in Matthew's "Etcheminian."

This form owes its specific name to its occurrence at the Straits of Belleisle, Labrador.

FORMATION AND LOCALITY.—**Lower Cambrian**: (**41a**) Limestone [Walcott, 1891b, p. 260] on the mainland beneath Topsail Head, Conception Bay; (**314e** [Walcott, 1886a, p. 150]) limestone at Topsail Head, Conception Bay; (**5r**) limestone near the railroad track 1.5 miles (2.4 km.) west of the railway station at Manuels, Conception Bay; (**5t**) shale and limestone nodules about 20 feet (6 m.) above the base of the Cambrian, on Redrock Point, near Chapple Cove, Hollywood Point, Conception Bay; (**51**) limestone on Smith Point, in Smith Sound, Trinity Bay; and (**314f**) limestone of B7 of the section at Bonne Bay [Walcott, 1891b, p. 255]; all in Newfoundland.

(**392a**) *Limestones [Walcott, 1891b, p. 254] at L'Anse au Loup on the north shore of the Straits of Belleisle, Labrador.*

(**3a**) 450 feet (137.1 m.) below the quartzite in the St. John formation and over 500 feet (152.4 m.) below the *Protolenus* zone of Matthew [Walcott, 1900, pp. 320–322], Hanford Brook; and (**301v** [Walcott, 1900, p. 322]) sandy shales of Division 2b of the "basal series" of Matthew, on Hanford Brook; both in St. John County, New Brunswick.

(**2o**) Limestone bowlders in conglomerate on shore at east entrance to harbor at Bic, Rimouski County, Quebec.

(**2b**) Limestone just north of Beman Park, in the northeastern part of the city of Troy, Troy quadrangle (U. S. Geol. Survey), Rensselaer County, New York.

(**304o**) Sandstone at Nuneaton, England.

(**1v**) Shales of No. 3 of the Silver Peak group, Barrel Spring section [Walcott, 1908f, p. 189], 3 miles (4.8 km.) north of Valcalda Spring and 4 miles (6.4 km.) west-northwest of the Drinkwater mine, Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County, Nevada.

(**57r** and **58s**) About 150 feet (46 m.) below the Middle Cambrian near the base of the limestones forming 3 of the Mount Whyte formation [Walcott, 1908c, p. 241 (10)], just above the tunnel on the north shoulder of Mount Stephen, about 3 miles (4.8 km.) east of Field, British Columbia.

Specimens somewhat doubtfully referred to this species occur at the following locality:

Lower Cambrian: (**2r**) Limestone bowlders in a conglomerate in a cut on the Intercolonial Railway, 2 miles (3.2 km.) west of Bic railway station, Rimouski County, Quebec.

MICROMITRA (PATERINA) LABRADORICA ORIENTALIS (Walcott).

Plate II, figure 11.

Iphidella labradorica orientalis WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 305–306. (Characterized as below as a new variety.)

Only one dorsal valve of this shell occurs in the collection. Its general form and surface characters are very much like those of *Micromitra (Paterina) labradorica swantonensis* (Walcott) [Pl. II, figs. 3, 3a–f]. The varietal name is given more on account of the fact that this shell occurs in China and the variety *swantonensis* on the eastern side of the North American continent than from any marked differences between the shells from the two localities. It may be that with a good series of shells from China differences would be found that are not to be determined with only the single shell for comparison.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**C9**) Lower limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 39 (3d list of fossils)], 3 miles (4.8 km.) southwest of Yenchuang, Sintai district, Shantung, China.

MICROMITRA (PATERINA) LABRADORICA SWANTONENSIS (Walcott).

Plate II, figures 3, 3a–f.

Kutorgina labradorica WALCOTT (in part) [not (BILLINGS)], 1886, Bull. U. S. Geol. Survey No. 30, Pl. IX, figs. 2, 2a–b. (The text reference [on page 104] includes only specimens belonging to the species *Micromitra (Paterina) labradorica*. The figures represent specimens of the variety *swantonensis*, which are redrawn in this monograph, Pl. II, figs. 3, 3a–b, respectively.)

Kutorgina labradorica swantonensis WALCOTT, 1890, Proc. U. S. Nat. Mus. for 1889, vol. 12, p. 36. (Characterized as a new variety.)

Paterina labradorica BEECHER [not (BILLINGS)], 1891, Am. Jour. Sci., 3d ser., vol. 41, footnote, pp. 345–346, Pl. XVII, figs. 1 and 2. (Discussed as the type of the new genus *Paterina*. Figs. 1 and 2 are copied from Walcott's figures, 1886b, Pl. IX, figs. 2b and 2, respectively.)

Kutorgina labradorica swantonensis WALCOTT, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 609, Pl. LXIX, figs. 2, 2a–b. (Characterized. Figs. 2, 2a–b are copied from Walcott, 1886b, Pl. IX, figs. 2, 2a–b.)

Paterina labradorica HALL and CLARKE [not (BILLINGS)], 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 247, fig. 258. (Genus *Paterina* described. Fig. 258 is copied from Walcott, 1886b, Pl. IX, figs. 2b and 2a.)

Iphidea bella HALL and CLARKE [not BILLINGS]. 1892, idem, p. 249, Pl. IV, figs. 4 and 5. (Mentioned.)

Iphidea bella Hall and Clarke (in part) [not Billings], 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 98, Pl. IV, figs. 8 and 9 (not fig. 54, p. 98, which is referred in this monograph to *Micromitra* (*Paterina*) *bella*). (Mentioned in the text. Figs. 8 and 9 are copied from Hall and Clarke, 1892a, Pl. IV, figs. 4 and 5, respectively.)

Iphidea labradorica Schuchert (in part) [not (Billings)], 1897, Bull. U. S. Geol. Survey No. 87, p. 234. (Accepts Billings's reference of "*Obolus labradoricus*" to *Iphidea*, but includes reference to specimens of both *Micromitra* (*Paterina*) *labradorica* and its variety *swantonensis*.)

Iphidea labradorica swantonensis (Walcott), Schuchert, 1897, idem, p. 234. (Merely changes generic reference.)

Iphidella labradorica swantonensis Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 307. (Merely changes generic reference.)

Iphidea swantonensis (Walcott), Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 201, figs. 234i and 234j, p. 199. (Described. Figs. 234i and 234j are copied from Walcott, 1886b, Pl. IX, figs. 2a and 2b, respectively.)

The general form of the two valves of this variety is so close to that of *Micromitra* (*Paterina*) *labradorica* (Billings) (p. 347) that it will not be necessary to repeat the description. The differences existing in the variety *swantonensis* have been mentioned in describing the species. The variety is exceedingly abundant in the *Olenellus*-bearing limestone, 2 miles (3.2 km.) east of Swanton, Vermont, in association with *Kutorgina cingulata* (Billings). Shell substance corneous.

The most interesting addition to our knowledge of the species is the discovery of the presence of a narrow area on the ventral valve and a short pseudodeltidium, as shown in a longitudinal section (Pl. II, figs. 3c–f). The existence of the area and pseudodeltidium in the ventral valve of the variety *swantonensis*, the form studied by Beecher, and in the dorsal valve of *M.* (*P.*) *labradorica*, was unknown at the time that Beecher [1891, p. 345] selected *M.* (*P.*) *labradorica swantonensis* (see p. 344) as the simplest form or prototype (*Paterina*), "preserving throughout its development the main features of a protegulum, and showing no separate or distinct stages of growth."

The discovery of the area and pseudodeltidium refers the species and its varieties to the genus *Micromitra* [Walcott, 1897b, p. 707].

The exact stratigraphic position of Locality 87 has not been made out, but from the associated species of *Agnostus* and *Ptychoparia*, it is evidently to be referred to the Middle Cambrian.

This form owes its varietal name to its occurrence in the vicinity of Swanton, Vermont.

Formation and locality.—**Middle Cambrian:** (**87**) Conglomeratic limestone 1 mile (1.6 km.) south-southwest of Highgate Falls, Franklin County, Vermont.

Lower Cambrian: (**25a**) *Limestone on the Hall (Donaldson's) farm, 2 miles (3.2 km.) east of Swanton;* (**319z**) sandy limestone 2.5 miles (4 km.) east of Swanton; (**26**) sandstone northeast of the Corman farm buildings, east of Highgate Springs; and (**319y**) sandstone 2 miles (3.2 km.) east-southeast of Highgate Springs; all in Franklin County, Vermont.

(**319x**) Limestone at the crossing of East Creek and Grove Street, 1.25 miles (2 km.) north of Rutland, Rutland County, Vermont.

Micromitra (Paterina) labradorica utahensis (Walcott).

Text figure 24, page 350; Plate II, figures 8, 8a.

Iphidella labradorica utahensis Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 306. (Characterized as a new variety.)

The general form of this variety is much like that of *Micromitra* (*Paterina*) *labradorica* (Billings). It differs from it in the fine, threadlike, concentric striæ of the outer surface, in this respect approaching *M. alabamaensis* (Walcott) and *M.* (*P.*) *superba* (Walcott). During the field season of 1906 fine specimens of this variety were found in the limestones 760 and 1,200 feet above the quartzitic sandstones referred to the Lower Cambrian. A ventral valve 6 mm. in width has a convex pseudodeltidium 1.25 mm. in length, with a width of 2.5 mm. at its slightly arched margins. The variety *swantonensis* also has a wide, convex pseudodeltidium (Pl. II, figs. 3e, 3f).

Formation and locality.—**Middle Cambrian:** (**30c**) About 1,050 feet (320 m.) above the Lower Cambrian and 3,350 feet (1,021.1 m.) below the Upper Cambrian in the shales forming 1d of the Swasey formation [Walcott, 1908f, p. 182], at the head of Dome Canyon, House Range [Walcott, 1908f, Pl. XIII], Millard County; (**3d**) concretionary limestone about 100 feet (30.5 m.) above the quartzitic sandstones of the Cambrian, at Ophir, Oquirrh Range, Tooele County; (**30p**) about 125 feet (38 m.) above the Cambrian quartzitic sandstones, on the north side of Ogden Canyon,

about 1 mile (1.6 km.) above its mouth, east of Ogden, Weber County; (**30u**) about 250 feet (76.2 m.) above the top of the Cambrian quartzitic sandstones, in sandy shales, 4 miles (6.4 km.) northwest of Promontory Point (on the "Lucin cut-off" of the Union Pacific Railway), about halfway up west end of ridge, north of Great Salt Lake, Boxelder County; (**34m**) limestone about 765 feet (233.2 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], 1 mile (1.6 km.) northwest of Geneva (Copenhagen), east of Brigham, Boxelder County; and (**32d**) shales about 150 feet (45.7 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], on the east side of the south fork of Paradise Dry Canyon (locally known as East Fork), east of Paradise, Cache Valley, Cache County; all in Utah.

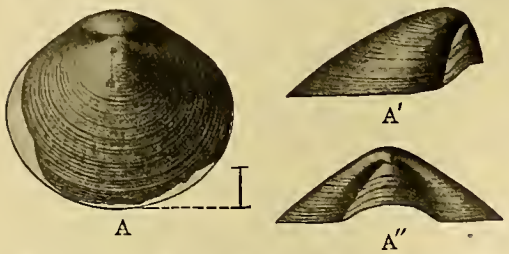

FIGURE 24.—*Micromitra (Paterina) labradorica utahensis* (Walcott). A, A', A'', Top, side, and back views of a ventral valve from Locality **54m**, Middle Cambrian limestones in Blacksmith Fork Canyon, Cache County, Utah (U. S. Nat. Mus. Cat. No. 51434).

(**54a**) About 750 feet (228.6 m.) above the Brigham quartzite and 3,440 feet (1,048.5 m.) below the Upper Cambrian in the shales forming 2a of the Ute limestone [Walcott, 1908f, p. 196]; (**54o**) about 900 feet (274.3 km.) above the Brigham quartzite and 3,300 feet (1,005.8 m.) below the Upper Cambrian in the limestone beds forming 1b of the Ute limestone [Walcott, 1908f, p. 196]; and (**54m**) *about 1,225 feet (373.4 m.) above the Brigham quartzite and 2,950 feet (899.2 m.) below the Upper Cambrian in the upper part of the limestone forming 1a of the Ute limestone* [*Walcott, 1908f, p. 195*]; all in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

MICROMITRA (PATERINA) LABRADORICA var. undt.

This form is distinguished from *Micromitra (Paterina) labradorica* (Billings) and its varieties by having much finer and more closely arranged concentric striæ. In other characters it approaches very closely to the typical forms of the species.

FORMATION AND LOCALITY.—**Lower Cambrian**: (**1v**) Shales of No. 3 of the Silver Peak group, Barrel Spring section [Walcott, 1908f, p. 189], 3 miles (4.8 km.) north of Valcalda Spring and 4 miles (6.4 km.) west-northwest of the Drinkwater mine, Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County, Nevada.

MICROMITRA (PATERINA) LOGANI (Walcott).

Plate II, figures 6, 6a–b.

Iphidea logani WALCOTT, 1897, Proc. U. S. Nat. Mus., vol. 19, pp. 711–712, Pl. LIX, figs. 2, 2a–b. (Described and discussed essentially as below as a new species. The specimen represented by figs. 2, 2a–b is redrawn in this monograph, Pl. II, figs. 6, 6a–b.)

Ventral valve conical, transverse in outline at the base, almost semicircular. Beak minute, incurving over the pseudodeltidium. Cardinal slopes rounded and flattened so as to form a fairly well-defined false area that is broken by a very wide triangular space. Pseudodeltidium arching upward, forming a narrow, sloping shelf beneath the beak, the angle of slope from the summit of the shell over the beak and pseudodeltidium being nearly the same as the slope from the summit to the front.

Surface marked by very fine concentric striæ and somewhat coarser lines of growth. Under a high power slight traces of radiating striæ may be observed. The concentric striæ pass around over the false area and cross the pseudodeltidium. Shell substance corneous.

Observations.—This specimen was received from Whiteaves, of the Geological Survey of Canada, as the type of *M. (P.) bella* (Billings). It differed, however, so materially from the description of that species [Billings, 1872b, pp. 477–478] and the figure illustrating it that I found it necessary to give it a distinct specific designation. (See pp. 335 and 345.)

This species approaches most nearly *M. (P.) crenistria* (Walcott) in its short pseudodeltidium and finely striated surface. It differs, however, in the character of the surface striæ, the form of the false area, and the pseudodeltidium.

The specimen bears the label "Trois Pistoles, 1868, T. C. Weston." It was collected from a bowlder in the conglomerate at that locality, and it is probably of Middle Cambrian age, though this can not be stated positively, as there are no associated fossils. Billings [1872b, p. 478] speaks of the occurrence of fragments of trilobites in the bowlder containing his type of *Micromitra (Paterina) bella*. He does not mention the genera or species.

The conglomerates of this formation, according to Logan, form 9 separate layers, from 2 to 16 feet thick, bedded in gray calcareous sandstone. The geologic age of the deposit of the matrix is supposed to be Upper Cambrian or Lower Ordovician. The age of the bowlders can only be determined by the fossils found in each.

The specific name was given in honor of Sir William E. Logan.

FORMATION AND LOCALITY.—**Middle? Cambrian**: (2n) Limestone in conglomerate on shore near Trois Pistoles, on St. Lawrence River, Province of Quebec, Canada.

MICROMITRA (PATERINA) MAJOR (Walcott).

Text figure 25.

Iphidella major WALCOTT (in part), 1905, Proc. U. S. Nat. Mus., vol. 28, p. 304. (Described and discussed somewhat as below as a new species. Specimens now referred to *Micromitra* (*Paterina*) *williardi* were included with the specimens representing *Micromitra* (*Paterina*) *major* when this description was given.)

Obolus smithi WALCOTT (in part), 1908, Smithsonian Misc. Coll., vol. 53, No. 3, Pl. VII, fig. 9 (not fig. 9a, which represents a specimen of *Obolus smithi*). (No text reference. Fig. 9, which is reproduced in this monograph as fig. 25, was inserted on Pl. VII of the above reference by mistake. All of the figures representing the two species (*Obolus smithi* and *Micromitra* (*Paterina*) *major*) happened to be grouped on the same preliminary plate, and when two figures were chosen to represent *Obolus smithi* in the paper referred to, one of the figures representing *Micromitra* (*Paterina*) *major* was accidentally included.)

Ventral valve subconical, with the apex slightly in front of the posterior margin. A minute beak appears to incurve over the pseudodeltidium. Cardinal slope rather abruptly rounded, so as to indicate a rather narrow false area. Pseudodeltidium broad and convex, with its lower margin arched so as to leave a space between it and the plane of the margin of the shell. Dorsal valve slightly convex, with a narrow area.

Surface, so far as can be determined from the badly preserved material, marked by rather strong growth lines and very fine concentric striæ. The largest dorsal valve has a length of 10.5 mm.; width, 13 mm. Only one small ventral valve is known.

FIGURE 25.—*Micromitra* (*Paterina*) *major* (Walcott). Exfoliated dorsal valve from Locality **56c**, Lower Cambrian beds in Rome formation ("Montevallo shale"), 1.125 miles (1.8 km.) northeast of Helena, Shelby County, Alabama (U. S. Nat. Mus. Cat. No. 51499).

This figure was publisbed [Walcott, 1908d, Pl. VII, fig. 9] as representing the dorsal valve of *Obolus smithi* and was given Cat. No. 51611a. As explained in the note under the second reference in the synonymy, this was a mistake.

Observations.—The material representing this species is more or less compressed and distorted in the argillaceous shales in which it occurs. In general form it is not unlike that of *Micromitra* (*Paterina*) *labradorica* (Billings) (Pl. II, figs. 2, 2a–f), but it differs in its nearly smooth surface and the position of the apex. It is, however, the southern Appalachian representative of that species. The original description of this species was based on specimens now referred to this species and to *Micromitra* (*Paterina*) *williardi* Walcott. Very good specimens of the latter are now available from two localities near Helena, Alabama.

This form owes its specific name to its large size.

FORMATION AND LOCALITY.—**Lower Cambrian**: (**56c**) *Rome ("Montevallo") formation along road just north of Buck Creek, 1.125 miles (1.8 km.) northeast of Helena;* and (**17b**) Rome ("Montevallo") formation 4 miles (6.4 km.) south of Helena; both in Shelby County, Alabama.

A dorsal valve similar to the one illustrated above occurs at the following locality:

Middle Cambrian: (**90**) Conasauga ("Coosa") shale on Edward's farm, near Craigs Mountain, about 10 miles (16.1 km.) southeast of Center, Cherokee County, Alabama.

MICROMITRA (PATERINA) PHILLIPSI (Holl).

Plate III, figure 8.

Obolella phillipsi HOLL, 1865, Quart. Jour. Geol. Soc. London, vol. 21, pt. 1, p. 102, figs. 10a–c. (Described as a new species. The specimen represented by figs. 10b and 10c is redrawn by Davidson, 1866, Pl. IV, figs. 17a and 17c, and Davidson's figures are copied in this monograph, Pl. III, fig. 8.)

Obolella ? phillipsi Holl, DAVIDSON, 1866, British Fossil Brachiopoda, vol. 3, pt. 7, No. 1, pp. 62–63, Pl. IV, figs. 17–19. (Described and discussed. Figs. 17a and 17c are drawn from the specimen represented in figs. 10b and 10c of the preceding reference, and are reproduced in this monograph, Pl. III, fig. 8.)

Kutorgina cingulata DAVIDSON [not (BILLINGS)], 1868, Geol. Mag., vol. 5, p. 312, Pl. XVI, fig. 10. (Discussed.)

Kutorgina cingulata Davidson [not (Billings)], 1871, British Fossil Brachiopoda, vol. 3, pt. 7, No. 4, pp. 342–343, Pl. L, fig. 25. (Discussed. Fig. 25 is copied from fig. 10 of preceding reference (p. 351) and erroneously referred to in the description of Pl. L as "*Kortugina cingulata.*")

Obolella phillipsi Holl, Phillips, 1871, Geology of Oxford and the Valley of the Thames, p. 68, Diagram XVII, fig. 12. (No text reference.)

Obolellus ? phillipsi (Holl), Roemer, 1876, Lethæa geognostica, pt. 1, Lethæa palæozoica, atlas, Pl. II, figs. 6a–d. (No text reference. Figs. 6a–d are copied from Davidson, 1866, Pl. IV, figs. 19, 17a, 17c, and 17b, respectively.)

Obolella phillipsia Holl, Dall, 1877, Bull. U. S. Nat. Mus. No. 8, p. 41. (Mentioned as possibly belonging to an undescribed genus.)

Kutorgina cingulata Davidson [not (Billings)], 1883, British Fossil Brachiopoda, vol. 5, pt. 2, p. 212. (Characterized.)

Kutorgina cingulata Walcott (in part) [not (Billings)], 1886, Bull. U. S. Geol. Survey No. 30, pp. 102–104. (Specimens now referred to *Micromitra (Paterina) phillipsi* were included with the specimens representing *Kutorgina cingulata* when this description was written.)

Kutorgina cingulata phillipsi (Holl), Matley, 1902, Quart. Jour. Geol. Soc. London, vol. 58, pt. 1, pp. 145–147. (Described and discussed as a variety.)

The original description by Holl follows:

Semicircular, slightly broader than long; hinge-line straight, nearly equal to the greatest width of the shell. Ventral valve prominent at the beak, depressed near the margin; beak small, round, pointed, and situated close to the posterior margin. Dorsal valve evenly convex, slightly depressed at the angles; umbo obtuse. A slight mesial depression toward the anterior border in both valves. Surface marked with numerous moderately fine, sharply defined, rather unequal, concentric striæ, at about their own width apart. Length of a large specimen one-fourth inch, width one-third inch.

The shell structure, where the outer layer has become exfoliated, is strongly punctate.

Observations.—Davidson [1868, p. 312] refers this form to *Kutorgina cingulata* (Billings) under the belief that the American and English species occur at the same relative geologic horizon. The American species, however, occurs in association with the *Olenellus* fauna. With the identification of the types of *Kutorgina cingulata* (Billings) and *Kutorgina labradorica* (Billings), the latter species being referred to *Micromitra* (*Paterina*), it is no longer possible to refer Holl's species to *Kutorgina cingulata*, it being clearly congeneric with *Micromitra* (*Paterina*) *labradorica*. It differs specifically from that species in a more depressed ventral valve.

The specific name was given in honor of Mr. J. Phillips.

Formation and locality.—**Upper Cambrian:** (**304g** [*Holl, 1865, p. 89*]) *Sandstones of the Hollybush series, Malvern Hills, between Herefordshire and Worcestershire, England.*

Lower Cambrian: (**304c**) "Malvern quartzite" at Raggedstone Hill; and (**304d**) "Malvern quartzite" at Midsummer Hill; both [Groom, 1902, p. 94] in the Malvern Hills, between Herefordshire and Worcestershire, England.

Micromitra (Paterina) prospectensis (Walcott).

Plate II, figures 4, 4a.

Kutorgina prospectensis Walcott, 1884, Mon. U. S. Geol. Survey, vol. 8, p. 19, Pl. IX, figs. 1, 1a–b. (Described as a new species. The specimens represented by figs. 1, 1a–b are redrawn in this monograph, Pl. II, figs. 4a and 4, respectively.)

Kutorgina prospectensis Walcott, 1886, Bull. U. S. Geol. Survey No. 30, pp. 106–107, Pl. IX, figs. 3 and 3a. (Copies original description and discusses species. Figs. 3 and 3a are drawn from the specimens figured by Walcott, 1884b, Pl. IX, figs. 1a and 1, respectively.)

Kutorgina prospectensis Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 610, Pl. LXIX, figs. 4 and 4a. (Mentioned. Figs. 4 and 4a are copied from Walcott, 1886, Pl. IX, figs. 3 and 3a, respectively.)

Iphidea prospectensis (Walcott), Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 234. (Merely changes generic reference.)

Iphidella prospectensis Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 307. (Merely changes generic reference.)

Ventral valve subconical, moderately elevated.

Dorsal valve moderately convex, the beak curving down to the posterior margin. The character of the area and pseudodeltidium is unknown. The surface slopes gently from the front to the highest point of the valve and arches down to the point of the beak. There is no trace of a mesial sinus. The cardinal slopes diverge from the beak at an angle of about 170°. Shell substance corneous.

The surface of both valves is marked by clearly defined, regular, concentric striæ that are slightly crenulated by striæ radiating from the beak outward to the margin. The concentric striæ show 10 in a distance of 1 mm. and 8 at the center of the dorsal valve.

Observations.—Nothing is known of the interior or the areas of either valve. The clearly defined concentric striæ, the thick corneous shell, and the long convex pseudodeltidium distinguish the species from all others of the genus known to me, with the possible exception of *Micromitra (Paterina) labradorica swantonensis* (Walcott). In the latter species, however, the striæ are less regular, and present quite a different appearance under the magnifier. In the original description [Walcott, 1884b, p. 19] the comparison was made with *Kutorgina cingulata* (Billings) as to certain points of resemblance between *M. (P.) prospectensis* and the young shells of *K. cingulata.*

This form owes its specific name to its occurrence on Prospect Mountain in the Eureka district, Nevada.

FORMATION AND LOCALITY.—**Lower Cambrian:** (**1m** and **1p**) Limestones of No. 2 of the Silver Peak group, Barrel Spring section [Walcott, 1908f, p. 189], about 2.5 miles (4 km.) south of Barrel Spring and 0.5 mile (0.8 km.) east of the road, in the extreme southeastern corner of the Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County; and (**52**) *arenaceous shales just above the Prospect Mountain quartzite, in a stratigraphic position similar to that of the Pioche shale* [*Walcott, 1908f, p. 184*], *at the top of Prospect Mountain, Eureka district* [*Hague, 1892, Atlas*], *Eureka County;* both in Nevada.

MICROMITRA (PATERINA) STISSINGENSIS (Dwight).

Plate III, figures 1, 1a–e.

Kutorgina stissingensis DWIGHT, 1889, Am. Jour. Sci., 3d ser., vol. 38, pp. 145–147, Pl. VI, figs. 5–8. (Described and discussed as a new species; see below for copy of paragraph on p. 146. The specimens represented by figs. 5, 6, and 8 are redrawn in this monograph, Pl. III, figs. 1c, 1, and 1a, respectively.)

Kutorgina stissingensis DWIGHT, 1891, Trans. Vassar Brothers' Inst. for 1887–1890, vol. 5, pt. 2, p. 105, figs. 5–8, p. 108. (Described and discussed as a new species.)

Iphidea stissingensis (Dwight), SCHUCHERT, 1897, Bull. U. S. Geol. Survey No. 87, p. 234. (Merely changes generic reference.)

Iphidella stissingensis (Dwight), WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 308. (Merely changes generic reference.)

All the specimens of this species known to me are more or less compressed in an argillaceo-arenaceous shale and impure limestone. As far as can be determined the ventral valve is obtusely conical, with the apex slightly incurving.

Dwight [1889, p. 145] in his original description mentions the presence of a distinct false area on the ventral valve, and I find in the two specimens traces of the area, also a wide, low, slightly convex pseudodeltidium.

The dorsal valve appears to have been slightly convex and to have resembled closely the general form and proportions of the same valve of *Micromitra (Paterina) labradorica* (Billings). One somewhat crushed specimen shows a very low false area and a rather broad, low pseudodeltidium somewhat like that of *M. (P.) labradorica.* It is too imperfect, however, for detailed description or illustration.

The surface of both valves is covered with very fine, sharp, slightly crenulated striæ and fine ridges of growth, crossed by very fine radiating striæ and fine radiating undulations of the same type as those in *Micromitra sculptilis* (Meek). The concentric striæ cross the false areas and pass over the pseudodeltidium. Shell substance corneous.

Dwight [1889, p. 146] describes the surface markings in detail as follows:

> The concentric ridges are somewhat wavy as seen under a strong magnifier; they are semicircular; a number of those lying nearest to the front margin run out along the upper part of the lateral margins, but the remainder and larger number terminate in regular order along the cardinal border. In front of the central portions of the shell the concentric ridges, which number about 12 to 15 to a millimeter, are regularly concentric; but nearer to the beak the number and the irregularity greatly increase. At a point about one-third the length of the shell from the beak there are 25 or more to the millimeter; as the radiating plications are numerous in this part, there is caused a complexity of curves, which under a powerful magnifier produces the effect of elegant and delicate basketwork. The radiating undulations are very irregular in position and number; they are not thoroughly continuous from the beak in specimens

observed, but appear at irregular intervals singly or in groups; while apt to be crowded around the beak, they are rare near the front margin. On the best specimens about 25 have been counted in the central part of the shell just forward of the beak; had they extended in equal distribution around it, quite to the cardinal border, there would have been about 50. They are also unequal in breadth; where they are somewhat regular, the interspaces about equal the plications in width; these plications are multiplied by implantation.

Observations.—Some young specimens show a surface ornamentation very much like that of *Micromitra sculptilis* (Meek) (Pl. III), but the ornamentation of the adult shell is quite distinct. As stated by Dwight [1889, p. 147], fragments of the shell in the shale might be taken for the shell of "*Lingulepis pinniformis*" (see *Lingulella* (*Lingulepis*) *acuminata* (Conrad), p. 545). He also calls attention to the general resemblance to *Micromitra* (*Paterina*) *labradorica* (Billings).

Attention has been called under the description of *M. alabamaensis* (Walcott) (p. 337) to the similarity of form and surface ornamentation between that species, *M.* (*P.*) *labradorica* (Billings), *M.* (*P.*) *labradorica swantonensis* (Walcott), and *M.* (*P.*) *stissingensis*.

An apparently identical form occurs at Mount Stephen, British Columbia, in association with *Ogygopsis klotzi* (Rominger). It has the same outline and shows the variations of surface ornamentation so characteristic of *M.* (*P.*) *stissingensis* (Dwight) from New York. The radial markings are lightly impressed and are so often entirely obscured that the Mount Stephen form frequently resembles the form described under the name of *Micromitra zenobia* (p. 342).

This form owes its specific name to its occurrence near Stissing, New York.

Formation and locality.—**Middle Cambrian**: (**367d** [Dwight, 1889, p. 145]) Limestone near Stissing, Dutchess County, New York.

A single specimen of a dorsal valve 3 mm. in width, that is apparently identical with shells of similar size from the type locality, occurs at the following locality:

Middle Cambrian: (**11m**) Drill cores of limestone in the Bonneterre limestone at horizons 10 and 20 feet (3 and 6 m.) above the Lamotte sandstone, St. Francois County, Missouri.

Apparently identical forms occur at the following locality:

Middle Cambrian: (**14s**) About 2,300 feet (701 m.) above the Lower Cambrian and 2,700 feet (823 m.) below the Upper Cambrian, in the *Ogygopsis* zone of the Stephen formation [Walcott, 1908f, p. 210], at the "fossil bed" on the northwest slope of Mount Stephen, above Field, on the Canadian Pacific Railway, British Columbia.

Micromitra (Paterina) stissingensis ora n. var.

This form is distinguished from the specimens tentatively referred to *Micromitra* (*Paterina*) *stissingensis* on Mount Stephen and from the typical specimens of the latter species in New York by its uniformly larger size and in its distinct radial striation. The Mount Stephen representatives of *M.* (*P.*) *stissingensis* frequently betray so little evidence of radial striation that they resemble *Micromitra zenobia*, a form which is associated with *M.* (*P.*) *stissingensis ora* and which differs from the latter variety in the entire absence of radial striation. It is possible that the Canadian forms will prove to be distinct from the New York species. Nothing is known of the cardinal area or pseudodeltidium of *M.* (*P.*) *stissingensis ora.*

Formation and locality.—**Middle Cambrian**: (**35k**) Shales in the Stephen formation on the west slope of the ridge between Mount Field and Wapta Peak, 1 mile (1.6 km.) northeast of Burgess Pass, above Field, British Columbia.

Micromitra (Paterina) stuarti Walcott.

Text figures 26A–B, page 355.

Micromitra (*Paterina*) *stuarti* Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 58, Pl. VII, figs. 8 and 8a. (Described and discussed as below as a new species. Figs. 8 and 8a are copied on page 355, figs. 26A and 26A″, respectively.)

Ventral valve subconical, with a minute beak arching slightly over a short pseudodeltidium. Cardinal slope with a rounded angle that extends from the beak to the posterolateral margin and defines a very narrow, flattened area on each side of a high triangular fissure that is covered for a short distance at the top by a very short, arched pseudodeltidium.

Dorsal valve rather strongly convex for a species of this genus; the highest part is at about the center of the shell, from whence the slope is very slight to the beak, and rather rapid to the front margin. Beak marginal above a low, broad arching of the posterior margin of the shell; area shown only by a very narrow margin where the shell bends toward the median line; no trace of a pseudodeltidium has been observed.

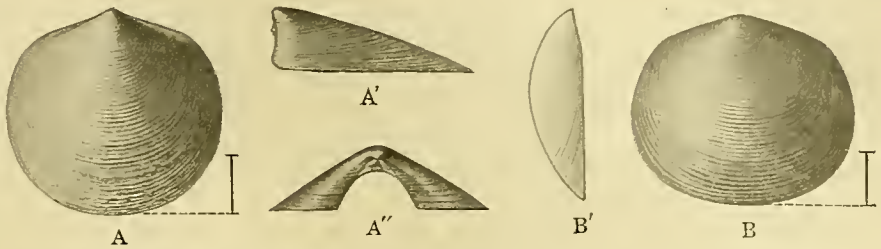

FIGURE 26.—*Micromitra (Paterina) stuarti* Walcott. A, A′, A″, Top, side, and back views of ventral valve, the type specimen (U. S. Nat. Mus. Cat. No. 51485a). B, B′, Top and side of dorsal valve (U. S. Nat. Mus. Cat. No. 51485b).

The specimens represented are from Locality **54n**, Middle Cambrian limestones in Blacksmith Fork Canyon, east of Hyrum, Cache County, Utah. Figures 26A and 26A″ are copied from Walcott [1908d, Pl. VII, figs. 8 and 8a].

Surface marked by narrow, rounded, concentric threadlike striæ or ridges with short striæ between them. Shell substance corneous.

The average size of adult shells is 8 mm. long by about the same width.

Observations.—This is one of the larger species of the genus. *Micromitra (Paterina) superba* (Walcott) occurs 16 feet (4.5 m.) below and *Micromitra (Iphidella) pannula* (White) 70 feet (21.3 m.) below in the same section.

This fine shell has a short pseudodeltidium much like that of *M. (P.) logani* (Walcott), but it differs in form and greater size; the same is true of *M. (P.) crenistria* (Walcott). It may be closely related to *M. (P.) labradorica utahensis* (Walcott), but the specimens of the latter are too imperfect for close comparison of form.

The specific name is given for my son, Benjamin Stuart Walcott, who assisted me in collecting the specimens during the summer of 1906.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**54n**) About 550 feet (167.6 m.) above the Brigham quartzite and 3,640 feet (1,109.5 m.) below the Upper Cambrian, in the limestones forming 2e of the Ute limestone [Walcott, 1908f, p. 197], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

MICROMITRA (PATERINA) SUPERBA (Walcott).

Text figures 27A–B; Plate II, figures 7, 7a–f.

Iphidea cnf.? *ornatella* HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, Pl. IV, figs. 6 and 7. (No text reference.)

Iphidea superba WALCOTT, 1897, Proc. U. S. Nat. Mus., vol. 19, p. 711, Pl. LIX, figs. 1, 1a–c. (Described. The specimens represented by figs. 1, 1a–c are redrawn in this monograph, Pl. II, figs. 7c, 7, 7a, and 7b, respectively.)

Ventral valve subconical, with a minute beak incurving over the pseudodeltidium. Cardinal slope slightly flattened so as merely to indicate an imperfectly defined rather narrow false area. In some specimens the curvature of the shell is practically continuous to the base of the pseudodeltidium. Pseudodeltidium broad, convex, with its lower margin broadly arched, so as to leave a considerable space between it and the line of the general plane of the shell.

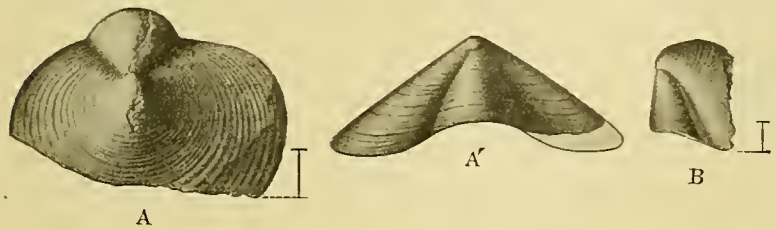

FIGURE 27.—*Micromitra (Paterina) superba* (Walcott). A, A′, Top and back views of ventral valve from Locality **54n**, Middle Cambrian limestones in Blacksmith Fork Canyon, Cache County, Utah (U. S. Nat. Mus. Cat. No. 51486). B, Side view of ventral valve showing pseudodeltidium, from Locality **54y**, at the same locality but from a slightly lower horizon than that of the specimen represented by figures 27A–A′ (U. S. Nat. Mus. Cat. No. 51491).

Dorsal valve slightly convex; most elevated a little in front of the small beak which projects a little over the broad open space beneath it. No traces of a false area or pseudodeltidium have been observed.

Surface with rather strong concentric striæ, and a few somewhat obscure lines of growth. On the ventral valve the striæ extend around to and cross the pseudodeltidium. Shell substance corneous.

Observations.—This is one of the larger species of the genus, being surpassed in size only by *Micromitra* (*Paterina*) *labradorica* (Billings). It is clearly distinguishable from *M.* (*P.*) *bella* (Billings) by its larger size, more depressed ventral valve, and the form of the pseudodeltidium. The dorsal valves of the two species are quite similar. It differs from *M. pealei* (Walcott) in its broad pseudodeltidium, false area, and surface markings.

One specimen has a length of 9 mm. and a little greater width. The area is vertical, the pseudodeltidium being broken away.

This species is represented by some fine specimens that occur in the lower part of the Middle Cambrian of northern Utah. *Micromitra* (*Iphidella*) *pannula* (White) occurs 54 feet (16.5 m.) lower in the section and *M.* (*Paterina*) *stuarti* Walcott 16 feet (4.5 m.) higher up.

Formation and locality.—**Middle Cambrian**: (**74**) Sandstone about 300 feet (91.4 m.) above the base of the Tonto group, at the head of Nunkoweap Valley; (**74d**) sandstone beds in "Tonto" shale, just above massive sandstones near mouth of Bass Canyon, on the south side of the Grand Canyon; and (**73a**) *"Tonto" sandstone in Chuar Valley;* all in the Grand Canyon of the Colorado, Arizona.

(**54n**) About 550 feet (167.6 m.) above the Brigham quartzite and 3,640 feet (1,109.5 m.) below the Upper Cambrian in the limestone forming 2e of the Ute limestone; (**54p**) about 525 feet (160 m.) above the Brigham quartzite and 3,665 feet (1,127.1 m.) below the Upper Cambrian in the shale forming 2f of the Ute limestone; and (**54y**) about 510 feet (155.4 m.) above the Brigham quartzite and 3,680 feet (1,121.7 m.) below the Upper Cambrian in the limestones forming 2g of the Ute limestone; all in Blacksmith Fork Canyon [Walcott, 1908f, p. 197], about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

(**8j**) About 575 feet (175.3 m.) above the unconformable base of the Cambrian in a shale which corresponds in position to shale No. 4 of the Dearborn River section [Walcott, 1908f, p. 202], on the ridge between Gordon and Youngs creeks, about halfway between Gordon Mountain and Cardinal Peak, Ovando quadrangle (U. S. Geol. Survey), Powell County, Montana.

Specimens that are somewhat doubtfully identified with this species occur in the following locality:

Upper Cambrian: (**160**) Sandstones forming a remnant of the Gallatin formation, which lies between the exposures of "porphyrite" on the east side of Willow Creek [Peale, 1896, areal geology sheet], 12 miles (19.2 km.) south-southwest of Threeforks, Threeforks quadrangle (U. S. Geol. Survey), Gallatin County, Montana.

Micromitra (Paterina) undosa (Moberg).

Text figures 28A–C.

Kutorgina undosa Moberg, 1892, Geol. Fören. i Stockholm Förhandl. for 1892, Bd. 14, Hft. 2, p. 112, Pl. III, figs. 10–12. (Described in Swedish as a new species; see below for free translation. Figs. 10–12 are copied in this monograph as figs. 28C, 28A, and 28B, respectively.)

Moberg describes this form essentially as follows:

No specimen shows the umbonal part of the ventral shell completely preserved, yet it seems as if the umbo had projected somewhat beyond the straight hinge margin. From the umbo the shell slopes gently in all directions, forming a rather feebly convex surface with even arch. The dorsal valve is more flattened and less evenly arched than the ventral and more transverse, with the anterior corners evenly rounded off. The area is not quite distinctly preserved on any specimen; the beak is situated quite near the posterior edge; it is sharply marked and projects with a somewhat blunt point. The ornamentation of the shell is very characteristic; the strongly marked lines of growth appear to be formed of a row of small bows, and on some specimens there are fine, short, sharp, radiating, subordinate, depressed lines. The shell is quite thick, and, it is thought, formed of a hornlike substance.

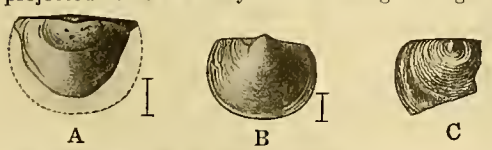

Figure 28.—*Micromitra* (*Paterina*) *undosa* (Moberg). A, B, Ventral valves. C, Dorsal valve.

The specimens represented by figures 28A and 28B are from Locality **390a**, drift blocks of Lower Cambrian sandstone at Stora Rör, Oeland Island; that represented by figure 28C is from Locality **390h**, drift blocks of Lower Cambrian sandstone on Nordmannaskär Island; both in Sweden. Figures 28A-C are copied from Moberg [1892, Pl. III, figs. 11, 12, and 10]. Figure 28B may be selected as representing the type specimen.

Two specimens of medium size are 4 mm. and 3.5 mm. long and 5 mm. and 4.75 mm. broad, respectively. Judging by the fragments the species must have attained considerable size.

Observations.—This form recalls *Micromitra* (*Paterina*) *labradorica* (Billings), which is found in association with *Discinella* at Bic, Canada. The size and character of the shell indicate its relationship to *Micromitra* rather than to *Kutorgina*.

Formation and locality.—**Lower Cambrian**: With *Discinella* in drift blocks of glauconitic quartzitic sandstone at the following localities [Moberg, 1892b, pp. 112 and 115]; (**310f**) west of Ekerum; (**390a**) *at several points near Stora Rör;* (**390d**) north of Röhälla; and (**390h**) on Nordmannaskär Island; all in the Kalmar district of the Geological Survey of Sweden, Oeland Island, Sweden.

Moberg [1892b, p. 114] describes some fragments which he refers to *Kutorgina* sp. From his statement that the fragments appear to be of a horny texture it is highly probable that they belong to the genus *Micromitra*.

Micromitra (Paterina) wapta Walcott.

Text figures 29A–B.

Micromitra (*Paterina*) *wapta* Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 59, Pl. VII, fig. 6. (Described and discussed as below as a new species. Fig. 6 is copied in this monograph as fig. 29A.)

Shell large and thick for a species of this genus. Ventral valve depressed, conical, with the apex above a narrow false area that is outlined by the abrupt curvature of the shell. As the shells usually occur compressed in the siliceous shale, the false area is concealed and the posterior slopes from the apex form a blunt angle at the apex. Dorsal valve transverse, moderately convex, with the posterior margin nearly straight and a little shorter than the greatest width of the valve; beak small, marginal; cardinal slope and false area unknown.

Surface marked by concentric, slightly irregular, rounded lines and ridges of growth that are grouped in bands of varying width; a few radiating striæ or lines occur on the central portions of one ventral valve; with a lens magnifying 20 diameters an occasional roughness can be seen in reflected light on the surface of some of the concentric ridges.

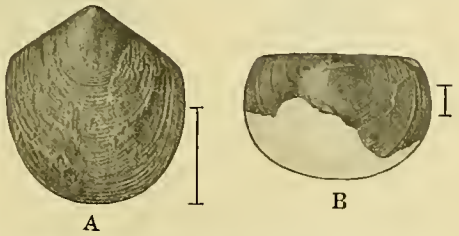

Figure 29.—*Micromitra* (*Paterina*) *wapta* Walcott. A, Exterior of ventral valve, the type specimen (U. S. Nat. Mus. Cat. No. 51402a). B, Portion of dorsal valve (U. S. Nat. Mus. Cat. No. 51402b).

The specimens represented are from Locality **35c**, a drift block of Lower Cambrian shale on Mount Bosworth, British Columbia. Figure 29A is copied from Walcott [1908d, Pl. VII, fig. 6].

Observations.—This is one of the largest species of the genus. One ventral valve has a length and breadth of 14 mm.; several are 9 to 11 mm. in diameter. It compares in size with *Micromitra* (*Iphidella*) *nyssa*, from the same geologic horizon in Montana, but the latter has a reticulate exterior surface of the *M.* (*I.*) *pannula* type. It was at first thought that this species might be the old shells of *Acrothele colleni* Walcott, but a careful comparison with the younger stages of growth of *M.* (*P.*) *wapta* shows that the latter has only very indefinite traces of the highly ornate surface of *Acrothele colleni* and that the apex of the ventral valve of *M.* (*P.*) *wapta* is imperforate and over the posterior margin and not on the general surface of the valve in advance of the margin, as in *Acrothele colleni*. The two species were found associated on Mount Bosworth. *M.* (*P.*) *wapta* is of the same type as *M.* (*P.*) *labradorica*, *M.* (*P.*) *prospectensis*, and *M.* (*P.*) *stissingensis*. It differs from all in having more irregular, less definite threadlike concentric lines, and in the manner in which the striæ are assembled in ridges.

The specific name is derived from Lake Wapta, which lies a little to the west of the type locality.

Formation and locality.—**Lower Cambrian**: (**35c**) *Drift blocks of siliceous shale supposed to have come from the Mount Whyte formation* [*Walcott, 1908f, p. 214*], *found on the south slope of Mount Bosworth, a short distance northwest of the Canadian Pacific Railway track between Stephen and Hector, eastern British Columbia, Canada.*

(**35e**) About 270 feet (82.3 m.) below the Middle Cambrian, in a greenish siliceous shale correlated with No. 3 of the Mount Whyte formation on Mount Bosworth [Walcott, 1908f, p. 214], in the amphitheater between Popes Peak and Mount Whyte, about 3 miles (4.8 km.) northwest of Lake Louise, southwest of Laggan on the Canadian Pacific Railway, Alberta, Canada.

Micromitra (Paterina) williardi Walcott.

Text figures 30A–E; Plate II, figures 9b–c.

Iphidella major Walcott (in part), 1905, Proc. U. S. Nat. Mus., vol. 28, p. 304. (Specimens now referred to *M.* (*P.*) *williardi* were included with the specimens representing *M.* (*P.*) *major* when this description was written.)

Micromitra (*Paterina*) *williardi* Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 60, Pl. VII, fig. 7. (Described and discussed as below as a new species. Fig. 7 is copied in this monograph as fig. 30A.)

Ventral valve subconical, with the apex over the posterior third of the subcircular margin of the valve; false area narrow but clearly defined by a rather sharp angle on the cardinal slopes that breaks the curvature of the shell a short distance from the margin of the pseudodeltidium; pseudodeltidium broad, convex, with its lower margin broadly arched so as to leave a space between it and the general plane of the margin of the shell. Some specimens of the pseudodeltidium are uniformly rounded, in others there is a narrow groove extending from the apex to the base, and on some a very narrow faint ridge is indicated.

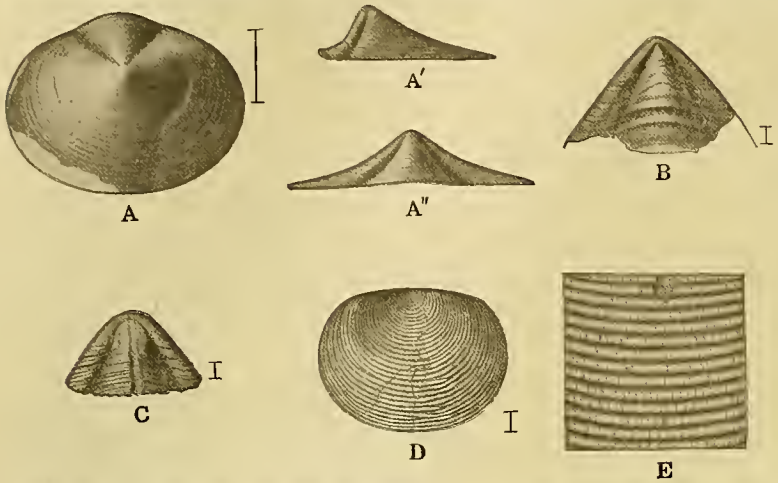

Figure 30.—*Micromitra* (*Paterina*) *williardi* Walcott. A, A′, A″, Top, side, and back of a partly flattened ventral valve (U. S. Nat. Mus. Cat. No. 51482a). B, Pseudodeltidium with strong lines and ridges of growth (U. S. Nat. Mus. Cat. No. 51482b). C, Pseudodeltidium with median furrow (U. S. Nat. Mus. Cat. No. 51482c). D, A small dorsal valve (U. S. Nat. Mus. Cat. No. 51482d). E, Enlargement of the outer surface near the front margin of a ventral valve, × 15 (U. S. Nat. Mus. Cat. No. 51482e). Figure 30A represents the type specimen.

The specimens represented are from Locality **56c**, 1.125 miles (1.8 km.) northeast of Helena, Shelby County, Alabama. Figure 30A is copied from Walcott [1908d, Pl. VII, fig. 7].

Dorsal valve slightly convex, transverse, and slightly rounded at the cardinal margin. No traces of a false area or pseudodeltidium have been observed.

The cast of the interior of the apex of the ventral valve shows a small apical callosity with two radiating grooves extending upward toward the front lateral margin of the shell.

Surface marked by very fine, strong, concentric, elevated striæ that in a specimen 10 mm. in diameter show seven elevated striæ in a distance of 1 mm.; the elevated striæ are crossed by very fine transverse striæ; the elevated striæ cross the false area parallel to its base and arch over the pseudodeltidium.

A ventral valve 10.5 mm. in diameter has a height of 2.5 mm.

Observations.—This species is closely related to *Micromitra* (*Paterina*) *superba* (Pl. II). It differs in having a longer pseudodeltidium, more finely elevated striæ on the surface, and a more sharply elevated apex to the ventral valve. It is the Lower Cambrian representative of *M.* (*P.*) *superba.*

The specific name is given in honor of Mr. T. E. Williard, who collected the type specimen.

Formation and locality.—**Lower Cambrian: (17b)** Rome ("Montevallo") formation, 4 miles (6.4 km.) south of Helena; and **(56c)** *Rome ("Montevallo") formation, 1.125 miles (1.8 km.) northeast of Helena;* both in Shelby County, Alabama.

IPHIDELLA Walcott,[a] subgenus of MICROMITRA.

[Iphidea.]

Kutorgina Walcott (in part) [not Billings], 1886, Bull. U. S. Geol. Survey No. 30, pp. 101–102. (Genus *Kutorgina* described, but description also includes reference to specimens now referred to *Micromitra*, *Micromitra* (*Paterina*), and *Micromitra* (*Iphidella*).)

Kutorgina Hall and Clarke (in part) [not Billings], 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 90–94. (Copies Walcott's description, 1886b, pp. 101–102, and discusses genus, but description and discussion also include reference to specimens now referred to *Micromitra*, *Micromitra* (*Paterina*), *Micromitra* (*Iphidella*), *Protorthis*, and *Billingsella*.)

Iphidea Billings, Walcott (in part), 1897, Proc. U. S. Nat. Mus., vol. 19, pp. 707–711. (Discussed. The genus as discussed includes species now referred to *Micromitra*, *Micromitra* (*Paterina*), and *Micromitra* (*Iphidella*).)

Iphidella Walcott (in part), 1905, Proc. U. S. Nat. Mus., vol. 28, p. 304. (Merely proposed to replace *Iphidea*, but includes reference to specimens belonging with *Micromitra*, *Micromitra* (*Paterina*), and *Micromitra* (*Iphidella*).)

Iphidea Billings, Grabau and Shimer (in part), 1907, North American Index Fossils, vol. 1, p. 201. (Described and includes species referred to each of the subgenera *Paterina* and *Iphidella*.)

Micromitra (*Iphidella*) Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 143. (Classification of subgenus.)

Iphidella was proposed to replace *Iphidea*, no species being given as the type. *Micromitra* Meek [1873, p. 479] has priority as the generic name, but as *Iphidella* was intended to include the ornamental crenulated as well as plain type of surface, those species having the former type are now grouped under *Iphidella* as a subgenus of *Micromitra*.

Type.—*Trematis pannulus* White.

The species included in this subgenus and the description of their ornamented surfaces are given under the description of *Micromitra* (p. 336).

Micromitra (Iphidella) louise Walcott.

Text figures 31A–B.

Micromitra (*Iphidella*) *louise* Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 56–57, Pl. VII, figs. 4 and 4a. (Discussed as below as a new species. Figs. 4 and 4a are copied in this monograph as figs. 31A and 31B, respectively.)

In form this species is not unlike *Micromitra pealei* (Pl. III, figs. 3, 3a–e) and the more elongate form of *Micromitra* (*Iphidella*) *pannula maladensis* (Pl. IV, figs. 2, 2a–g). It differs from both forms mentioned in its surface characters. In the latter respect it is more like *M.* (*I.*) *nyssa* (Pl. III, figs. 9, 9a), but the form of *M.* (*I.*) *louise* is more elongate and the apex of the ventral valve is nearer to the posterior margin; the shell also appears to have been thicker. The surface characters are exceedingly minute. Under a glass magnifying twenty diameters the surface looks much like that of the anterior half of Plate IV, figure 1s. The largest ventral valve in the collection has a length of 7.5 mm. and a width of 7 mm.; elevation, 1 mm.

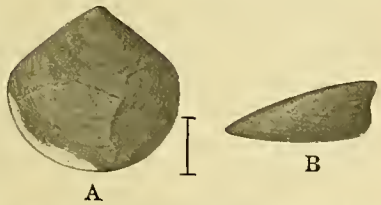

Figure 31.—*Micromitra* (*Iphidella*) *louise* Walcott. A, Flattened and partly distorted ventral valve, the type specimen (U. S. Nat. Mus. Cat. No. 51401a.) B, Side of laterally compressed ventral valve (U. S. Nat. Mus. Cat. No. 51401b).

The specimens represented are from the Lower Cambrian siliceous Lake Louise shale, at Locality 35d, on the north side of Lake Louise, Alberta, Canada. The figures are copied from Walcott [1908d, Pl. VII, figs. 4 and 4a].

Micromitra (*Iphidella*) *louise* is the oldest known brachiopod from the Cambrian of the Canadian Rocky Mountains. In the Lakes Louise and Agnes section it is 3,150 feet (960.1 m.) below the Middle Cambrian, and 2,760 feet (841.2 m.) below the horizon which is correlated on the basis of the associated faunas with that at which *M.* (*I.*) *nyssa* occurs in Montana. It occurs in a fine, hard, dark-gray, siliceous shale in association with *Hyolithes*, *Cruziana*, and a fragment indicating the free cheek of a trilobite.

[a] The synonymy for this subgenus does not give a complete record of the various genera under which the species now included in *Iphidella* were formerly placed; it includes only those references in which the subgenus is discussed or described. For the sake of completing the record the remaining mere generic references are here listed:

Trematis White [1874, p. 6].
Iphidea Linnarsson [1876, p. 25].
Trematis White [1877, p. 36].
Kutorgina Walcott [1887, p. 190; 1891a, p. 609].
Iphidea Schuchert [1897, p. 234].
Iphidea Matthew [1902b, p. 110].
Iphidea Grönwall [1902, p. 40].
Kutorgina Pack [1906, p. 296].

This form owes its specific name to its occurrence on the shores of Lake Louise.

FORMATION AND LOCALITY.—**Lower Cambrian: (35d)** About 3,150 feet (960.1 m.) below the Middle Cambrian in the siliceous Lake Louise shale [Walcott, 1908f, p. 216] in cliff on the north side of Lake Louise, at its upper end, southeast of Laggan on the Canadian Pacific Railway, Alberta, Canada.

MICROMITRA (IPHIDELLA) NYSSA Walcott.

Plate III, figures 9, 9a.

Micromitra (*Iphidella*) *nyssa* WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 57, Pl. VII, fig. 5. (Described and discussed as below as a new species. Fig. 5 is copied in this monograph, Pl. III, fig. 9.)

Ventral valve subcircular in outline, with the posterior margin almost transverse; form depressed, conical, with a minute beak incurving over the pseudodeltidium. The cardinal slope is compressed in all the specimens, but it indicates that there was an imperfectly defined narrow area. Pseudodeltidium, as far as can be determined, broad and short, with its lower margin broadly arched. Dorsal valve slightly convex, beak marginal. No traces of a false area or pseudodeltidium have been observed.

Surface marked by concentric striæ and lines of growth that are crossed obliquely by two sets of fine elevated lines. The crossing of the latter lines forms minute, shallow, rhomboidal pits, which give to the surface the appearance of a fine network. On the ventral valve the striæ cross the pseudodeltidium. Shell substance corneous.

Observations.—This is one of the largest shells of this genus. The ventral valve has a length of 11 mm., width 13 mm. In form it resembles *Micromitra* (*Paterina*) *labradorica* (Billings) and in surface characters *M.* (*Iphidella*) *ornatella* (Linnarsson) and some varieties of *M.* (*I.*) *pannula* (White).

FORMATION AND LOCALITY.—**Middle Cambrian: (4q)** About 315 feet (96 m.) above the unconformable base of the Cambrian and 190 feet (57.9 m.) above the top of the quartzitic sandstones, in a shale which corresponds in stratigraphic position to the upper part of shale No. 6 [see Walcott, 1908f, p. 202], on the ridge between Gordon and Youngs creeks, about halfway between Gordon Mountain and Cardinal Peak, Ovando quadrangle (U. S. Geol. Survey), Powell County, Montana.

MICROMITRA (IPHIDELLA) ORNATELLA (Linnarsson).

Plate III, figures 6, 6a–d.

Iphidea ornatella LINNARSSON, 1876, Bihang till K. svensk. Vet.-Akad. Handl., Bd. 3, No. 12, pp. 25–26, Pl. III, figs. 42a–e, 43a–c. (Described and discussed in English as a new species; see below for copy.)

Iphidea ornatella Linnarsson, HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 97–98. (Mentioned in discussion of genus *Iphidea*.)

Iphidea ornatella Linnarsson, GRÖNWALL, 1902, Danmarks Geol. Undersøgelse, Række 2, No. 13, p. 40. (Mentioned in Swedish.)

The original description by Linnarsson follows:

Shell small, transversely oval; sides and front rounded; hinge line straight, or nearly so, shorter than the width of the shell; cardinal angles rounded. Surface marked with retiform eminences, including small excavations. The eminences often swell out and become higher at the crossing points, thereby giving to the surface a somewhat granulated appearance (as in fig. 43). In some specimens there are also more or less distinct radiating ridges, especially near the median line of the shell. The shell substance is apparently corneous, but I have not been able to discern more than one layer.

The color in the specimens from Bornholm is black, in those from Westrogothia more brown. Ventral valve convex, subconical. Beak erect and pointed, pierced by a minute round foramen. The posterior, visible only in one specimen, is truncated, so as to form a false area, which has in the middle a triangular fissure, arched over, in the upper part only, by a convex pseudodeltidium. Dorsal valve less convex, somewhat flattened along the middle; greatest height at the beak, which is not, however, so prominent as in the opposite valve. Hinge area not visible in any of the specimens. Interior of both valves unknown. Two specimens measured: Length 3 mm., breadth 4 mm.; and length 2 mm., breadth 3 mm.

Linnarsson [1876, p. 26] speaks of the presence of a minute foramen, but after the study of several finely preserved ventral valves from the *Paradoxides* zone of Andrarum, Sweden, I am led to believe that what he considered to be an apical foramen is the minute longitudinal

furrow just in front of the beak, which is shown on the specimens before me and on other species as mentioned in the discussion of the genus *Micromitra* (p. 335). At first sight it is very difficult to determine whether there is an apical foramen or not, but with a strong light and a high power the furrow in *M.* (*I.*) *ornatella* is seen to be smooth at the bottom and to show no trace of an opening down through the shell.

The surface ornamentation is of the same type as that of *M.* (*I.*) *pannula* (White). It differs in details, but the range of variation in the surface of *M.* (*I.*) *pannula* (White) is greater than the differences between its surface and that of *M.* (*I.*) *ornatella*.

The most marked distinction between the two species is in the form of the false area and pseudodeltidium of the ventral valve; the dorsal valve of *M.* (*I.*) *pannula* also appears to be more elevated. These differences, however, might disappear if we had a large number of specimens of *M.* (*I.*) *ornatella* for comparison. With the material we now have they appear to be of specific value.

One specimen from Andrarum shows a narrow area on each side of the wide, low, triangular opening, the pseudodeltidium being broken away. Shell substance corneous.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**8w**) Limestones of the *Paradoxides forchhammeri* zone, at Andrarum, 20 miles (32.2 km.) northwest of Simrishamn, Province of Christianstad; (**320f**) limestone at Andrarum, 20 miles (32.2 km.) northwest of Simrishamn, Province of Christianstad; (**320n**) *limestones of the Paradoxides forchhammeri zone at Lovened, Djupadal, 19 miles (30.6 km.) south-southeast of Skara, Province of Skaraborg;* and (**320y**) limestones of the *Paradoxides forchhammeri* zone at Gudhem, 12.5 miles (20.1 km.) south-southeast of Skara, Province of Skaraborg; all in Sweden.

(**324c**) Shales of Étage 1d [Brögger] at Krekling, in Sandsvär, Norway.

(**16h**) Limestones of the *Paradoxides forchhammeri* zone at Borregaard, Bornholm Island, Denmark.

(**6g**) Limestone near the base of the Middle Cambrian, the lowest horizon carrying *Paradoxides*, northwest side of Chapple Arm Harbor, about 1 mile (1.6 km.) from its head, Trinity Bay, Newfoundland.

MICROMITRA (IPHIDELLA) PANNULA (White).

Text figure 32, page 362; Plate IV, figures 1, 1a–t, 3, 3a.

Trematis pannulus WHITE, 1874, U. S. Geog. Surveys W. 100th Mer., Prelim. Rept., p. 6. (Described as a new species.)

Trematis pannulus WHITE, 1877, idem, Final Rept., vol. 4, pt. 1, pp. 36–37, Pl. I, figs. 4a and 4b. (Described and discussed. The specimen represented by figs. 4a and 4b is redrawn in this monograph, Pl. IV, fig. 1g.)

Kutorgina pannula (White), WALCOTT, 1886, Bull. U. S. Geol. Survey No. 30, p. 105, Pl. VII, figs. 3, 3a; Pl. VIII, figs. 2, 2a–c. (Copies the description and discussion given by White, 1877, pp. 36–37. Pl. VII, figs. 3 and 3a, are drawn from the specimen figured by White, 1877, Pl. I, figs. 4a and 4b. The three specimens represented by figs. 3 and 3a, 2 and 2a, and 2b and 2c are redrawn in this monograph, Pl. IV, figs. 1g, 1j, and 1k and 1p, respectively.)

Kutorgina pannula (White), WALCOTT, 1887, Am. Jour. Sci., 3d ser., vol. 34, p. 190, Pl. I, figs. 14, 14a–b. (Characterized from a new locality. The two specimens represented by figs. 14 and 14a and fig. 14b are redrawn in this monograph, Pl. IV, figs. 1m and 1q and figs. 1k and 1p, respectively.)

Kutorgina pannula (White), WALCOTT, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 609, Pl. LXIX, figs. 5, 5a–f. (Mentioned. Figs. 5, 5a, and 5b are copied from Walcott, 1886b, Pl. VIII, figs. 2a, 2, and 2b; figs. 5c, 5e, and 5f from Walcott, 1887, Pl. I, figs. 14, 14b, and 14a; and fig. 5d from Walcott, 1886b, Pl. VII, fig. 3. The six specimens represented by figs. 5 and 5a and 5b–f are redrawn in this monograph, Pl. IV, figs. 1j, 1k, 1m, 1g, 1p, and 1q, respectively.)

Iphidea pannulus (White), SCHUCHERT, 1897, Bull. U. S. Geol. Survey No. 87, p. 234. (Merely changes generic reference.)

Iphidea pannula (White), MATTHEW, 1902, Trans. Roy. Soc. Canada for 1902, 2d ser., vol. 8, sec. 4, No. 3, p. 110. (Characterized from a new locality.)

Iphidella pannula (White), WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 307. (Merely changes generic reference.)

Kutorgina pannula (White), PACK, 1906, Jour. Geol., vol. 14, No. 4, p. 296, Pl. II, figs. 1, 1a–c. (Discussed. Figs. 1b and 1c are outline drawings after Walcott's figures, 1886b, Pl. VIII, figs. 2a and 2b; fig. 1a is an outline drawing after Walcott's figure, 1891a, Pl. LXIX, fig. 5d.)

Iphidea pannulus (White), GRABAU and SHIMER, 1907, North American Index Fossils, vol. 1, p. 201. (Described.)

Micromitra (*Iphidella*) *pannula* (White), WALCOTT, 1908, Canadian Alpine Journal, vol. 1, No. 2, p. 244, Pl. I, figs. 1, 1a–c. (No text reference. Figs. 1, 1a–c are copied in this monograph, Pl. IV, figs. 1r, 1e, 1d, and 1q, respectively.)

Ventral valve conical; beak slightly incurving over the pseudodeltidium. Cardinal slopes rounded and flattened so as to form a not very strongly defined false area on each side of the wide, triangular opening, which is crossed toward the summit by a low, highly rounded pseudo-

deltidium; the latter projects directly outward at right angles to the false area and then curves abruptly, so as to be almost flat across the center. A narrow, slight median groove extends from beneath the apex to the posterior margin. Another specimen shows a portion of a pseudodeltidium that is somewhat less elevated than the one described. The apex of the valve just outside of the extreme point of the beak is crossed by a very minute longitudinal depression that is visible only under a strong magnifier.

Dorsal valve slightly convex, sloping regularly from the front margin to the small beak, which is slightly incurved at the margin of the valve. False area clearly defined; in a specimen 10 mm. in width the area has a width of a little over 1 mm. at the side, narrowing to a point at the apex. It is broken midway by a wide triangular opening, which is filled in by a depressed pseudodeltidium. The sides of the deltidium turn in at nearly a right angle for a short distance to the general plane of the pseudodeltidium, which extends across from side to side. Posterior margin slightly arched, and its general surface broken midway by a narrow, distinct groove, which extends from beneath the beak back to the posterior margin. (See Pl. IV, fig. 1f.) Striæ of growth extend across the false areas and pseudodeltidia in both valves; shell substance corneous.

FIGURE 32.—*Micromitra* (*Iphidella*) *pannula* (White). Ventral valve, showing setæ, from Locality 35k, Middle Cambrian, Burgess shale member of the Stephen formation, near Field, British Columbia. This specimen is unique in being the first Cambrian brachiopod in which the setæ have been observed. The preservation of so frail a portion of the anatomy of the brachiopod is no more remarkable, however, than the presence in the same shales of annelids showing the fringe of setæ around the mouth; of crustaceans of many kinds showing the branchiæ and appendages; of trilobites with antennæ, branchiæ, legs, etc.; of holothurians showing the podia and the dental plates; of medusæ, sponges, etc.—a fauna which is now being described and figured in volume 57 of the Smithsonian Miscellaneous Collections.

The surface ornamentation of this species is as highly ornamental as that of any Cambrian brachiopod. It appears to be formed of a very fine network of oblique raised lines, which divide it up into minute diamond-shaped pore-like pits, a surface which resembles, under a strong lens, the texture of finely woven cloth. A closer examination, however, of some of the larger shells shows, on the outer margin, crenulated concentric lines, and a little farther back on the shell more deeply crenulated lines; still farther back the points of the crenulations unite so as to form a solid network that gives the appearance of oblique lines crossing at nearly right angles (Pl. IV, fig. 1s).

The surface marking is so strongly characteristic that the presence of the species has been detected a number of times by finding very small fragments of the shell. It not infrequently happens that in old shells the surface characters have been almost entirely worn away, traces of the ornamentation remaining only in the vicinity of the cardinal slopes. The wearing of the surface near the umbo is shown in Plate IV, figure 1m.

In some specimens from Montana (Pl. IV, fig. 1s) the surface is most beautifully preserved, and at first glance there appears to be a specific difference between it and the specimens from Mount Stephen, central Nevada, and the Colorado Canyon. This may be seen by comparing figures 1r and 1s (Pl. IV). There are, however, intermediate forms that possess more or less of the characteristics shown by the two figures. In some specimens there are fine, radiating undulations extending from the apex to the margin that give to the shell an appearance much like that of the young of *M. sculptilis* (Meek) and *M.* (*Paterina*) *stissingensis* (Dwight). These are finely shown by Plate IV, figure 1n. The surface ornamentation is much like that of *M.* (*Iphidella*) *ornatella* (Linnarsson) of Sweden. It differs but slightly in the form of the depression formed by the union of the crenulated striæ.

This species has a wide geographic distribution, and it also occurs both in the Lower Cambrian in the *Olenellus* fauna, and in the Middle Cambrian in the *Olenoides* fauna. Its range in

the West is from Nevada to Montana, and in the Appalachian region from eastern New York to Alabama. At first, on account of its highly ornamented surface, I was led to think that it might belong to a distinct genus from *Micromitra*, but comparisons with *M. sculptilis* (Meek) and the simple ornamentation of *M.* (*Paterina*) *bella* (Billings) show transitions in the ornamentation between the otherwise distinct forms.

Varieties of Micromitra (*Iphidella*) *pannula.*—In collections from the Middle Cambrian limestones of northern Utah and southern Idaho, material has been selected for illustration which represents varieties of form and surface markings of *Micromitra* (*Iphidella*) *pannula* (White) that might be given specific names were it not for the intermediate phases which occur at the same locality with the varieties. The specimens from near Malade, Idaho (Pl. IV, figs. 2, 2a–g), and many not illustrated, show a wide variation in outline and surface. Another series from near Ophir, Utah (Pl. IV, figs. 4, 4a–f), illustrate the entire evolution of the "*pannula*" type of surface, from the concentric striæ to the fine network of oblique, raised lines dividing the surface into minute, diamond-shaped depressions. In some of the examples from Malade the ridges are so sharp and clear that the surface has a honeycomb-like appearance (Pl. IV, fig. 2g).

The surface of *M.* (*I.*) *pannula* (White) is composed of porelike pits formed by obliquely crossing, elevated lines (Pl. IV, figs. 1n–1s), and for convenience of reference the forms showing variations from this may be separated into the varieties *maladensis* and *ophirensis* (pp. 364–365).

Formation and locality.—**Upper Cambrian:** (**96**) Limestones near the ford on the Cedartown road, 1.5 miles (2.4 km.) south of Rome, Floyd County, Georgia.

Middle Cambrian: (**14s**) About 2,300 feet (701 m.) above the Lower Cambrian and 2,700 feet (823 m.) below the Upper Cambrian, in the *Ogygopsis* zone of the Stephen formation [Walcott, 1908f, p. 210], at the "fossil bed," on the northwest slope of Mount Stephen, above Field on the Canadian Pacific Railway; (**57j**) about 2,000 feet (609.6 m.) above the Lower Cambrian in the limestones forming 2 of the Stephen formation [Walcott, 1908c, p. 237 (6)], just east of the "fossil bed" on the northwest slope of Mount Stephen, above Field on the Canadian Pacific Railway; (**58j**) about 1,900 feet (579 m.) above the Lower Cambrian near the base of the limestone forming 2 of the Stephen formation [Walcott, 1908c, p. 238 (7)]; on the east side of Mount Stephen about 3,000 feet (914 m.) above the Canadian Pacific Railway track, 3 miles (4.8 km.) east of Field; and (**35k**) Burgess shale member of the Stephen formation on the west slope of the ridge between Mount Field and Wapta Peak, 1 mile (1.6 km.) northeast of Burgess Pass, above Field; all in British Columbia.

(**57g**) About 1,700 feet (518 m.) above the Lower Cambrian and 3,250 feet (991 m.) below the Upper Cambrian in the siliceous shales forming 2d of the Stephen formation [Walcott, 1908f, p. 211], on Mount Bosworth, north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide between British Columbia and Alberta, Canada.

(**4q** and **4q′**) 315 and 310 feet (96 and 94.5 m.), respectively, above the unconformable base of the Cambrian and 190 and 185 feet (57.9 and 56.4 m.), respectively, above the top of the quartzitic sandstones in shales and limestones which correspond in position to the upper part of shale No. 6 of the Dearborn River section [see Walcott, 1908f, p. 202], on the ridge between Gordon and Youngs creeks, about halfway between Gordon Mountain and Cardinal Peak, Ovando quadrangle (U. S. Geol. Survey), Powell County; (**302t**) limestone northeast of Logan, Threeforks quadrangle (U. S. Geol. Survey), Gallatin County; and (**149a**) limestone at the forks of Pole Creek, above Cherry Creek basin, Threeforks quadrangle (U. S. Geol. Survey), Madison County; all in Montana.

(**55c** and **163**)[a] Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], about 50 feet (15.2 m.) above the Brigham quartzite and 2,755 feet (839.7 m.) below the Upper Cambrian, in a ravine running up into Danish Flat from Mill Canyon; and (**59f**) limestones immediately underlying the Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], in a saddle north of the creek which flows into Mill Canyon from the west; both about 5 miles (8 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho.

(**5b** and **54s**) Dark blue-gray Langston limestone [Walcott, 1908f, p. 198] just above the Cambrian quartzitic sandstones, north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

(**31v**) 650 feet (198 m.) above the Lower Cambrian and 3,750 feet (1,143 m.) below the Upper Cambrian, in shales at the top of the limestone forming 1a of the Howell formation [Walcott, 1908f, p. 182], northeast side of Dome Canyon, about 4 miles (6.4 km.) west-southwest of Antelope Springs; and (**31s**) 490 feet (149.4 m.) above the Lower Cambrian and 3,925 feet (1,196.3 m.) below the Upper Cambrian, in the pinkish, argillaceous shale forming 1d of the Howell formation [Walcott, 1908f, p. 182], south side of Dome Canyon, about 1 mile (1.6 km.) below the divide and 3 miles (4.8 km.) west-southwest of Antelope Springs; both in the House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah.

(**14t**) Limestone lying on the slope between the Cambrian quartzite and the massive blue limestone 100 feet (30.5 m.) above, Mount Nebo Canyon, 3 miles (4.8 km.) southeast of Mona, Juab County; (**55u**) limestones about 200

[a] This species also occurs in Locality **55e**.

feet (61 m.) above the Lower Cambrian [see Walcott, 1908f, p. 171], 0.25 mile (0.4 km.) below the Maxfield mine, in Big Cottonwood Canyon, on the west front of the Wasatch Mountains southeast of Salt Lake City, Salt Lake County; (**30a**) shale on the north side of Big Cottonwood Canyon, 1 mile (1.6 km.) below Argenta, in the Wasatch Mountains southeast of Salt Lake City, Salt Lake County; and (**541**) about 500 feet (152.4 m.) above the Brigham quartzite and 3,700 feet (1,127.8 m.) below the Upper Cambrian in the Spence shale member of the Ute limestone [Walcott, 1908f, p. 197], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County; all in Utah.

(**31**) Shales at the Chisholm mine; and (**333** [Pack, 1906, p. 296]) shales at the Abe Lincoln mine; both on the southwest slope of the Ely Mountains, 3 miles (4.8 km.) northwest of Pioche, Lincoln County, Nevada.

(**73a**) "Tonto" sandstone in Chuar Valley; and (**74**) sandstone about 300 feet (91.4 m.) above the base of the Tonto group, at the head of Nunkoweap Valley; both in the Grand Canyon of the Colorado, Arizona.

(**14**) Limestones overlying the sandstones of the Rome formation, near the wagon road and in a quarry near the railroad track, 7 miles (11.2 km.) southwest of Rome, Floyd County, Georgia.

(**101**) Rogersville shale, just above the road in the hill west of the schoolhouse, 3.5 miles (5.6 km.) southwest of Rogersville on the road to Melinda Ferry [Keith, 1896a, areal geology sheet], Hawkins County, Tennessee.

Lower Cambrian: (**57r** and **58s**) About 150 feet (46 m.) below the Middle Cambrian near the base of the limestones forming 3 of the Mount Whyte formation [Walcott, 1908c, p. 241 (10)]; and (**35f**)[a] about 300 feet (91 m.) below the Middle Cambrian in the limestone forming 6 of the Mount Whyte formation [Walcott, 1908c, p. 242 (11)]; both just above the tunnel on the north shoulder of Mount Stephen, about 3 miles (4.8 km.) east of Field, British Columbia, Canada.

(**41**) Limestone in the Pioche shale [Walcott, 1908a, p. 11], on a ridge 2.5 miles (4 km.) northwest of the town of Cherry Creek, White Pine County; (**30**) limestone 8 miles (12.8 km.) north of Bennetts Spring, on the west slope of the Highland Range, Lincoln County; and (**31a**) *limestone interbedded in the Pioche shale* [*Walcott, 1908a, p. 11*], *just above the quartzite on the east side of the anticline, near Pioche, Lincoln County;* all in Nevada.

(**34**) Limestone on roadside a little west of the bridge over Poultney River at Low Hampton, about 5 miles (8 km.) east-northeast of Whitehall, Whitehall quadrangle (U. S. Geol. Survey), Washington County; (**38a**) limestone 2 miles (3.2 km.) south of North Granville, on the road which turns south from the road running between that village and Truthville, 4 miles (6.4 km.) west-northwest of Granville, Fort Ann quadrangle (U. S. Geol. Survey), Washington County; and (**44b**) limestone near North Chatham in the northern part of the Kinderhook quadrangle (U. S. Geol. Survey), Columbia County; all in New York.

(**4v**) About 200 feet (61 m.) above the unconformable base of the Cambrian and 75 feet (22.9 m.) above the top of the quartzitic sandstones in a shale which corresponds in stratigraphic position to shale No. 6 of the Dearborn River section [Walcott, 1908f, p. 202], Gordon Creek, 6 miles (9.6 km.) from South Fork of Flathead River, Ovando quadrangle (U. S. Geol. Survey), Powell County, Montana.

Specimens that are somewhat doubtfully referred to this species occur at the following localities:

Middle Cambrian: (**55e**) Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], about 50 feet (15.2 m.) above the Brigham quartzite, and 2,755 feet (839.7 m.) below the Upper Cambrian, in a ravine running up into Danish Flat from Mill Canyon, about 6 miles (9.6 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho.

(**54q**) A drift block supposed to have come from the horizon of Locality **32x**, a horizon correlated with the shales forming 2d of the Bloomington formation in Blacksmith Fork Canyon [Walcott, 1908f, p. 195], in Wasatch Canyon, east of Lakeview ranch, about 5 miles (8 km.) north of Brigham, Boxelder County, Utah.

(**13k**) Shales of Matthew's [1903, p. 15] Coldbrook, above the great falls in Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

MICROMITRA (IPHIDELLA) PANNULA MALADENSIS (Walcott).

Plate IV, figures 2, 2a–g.

Iphidella pannula maladensis WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 306. (Characterized as a new variety.)

Surface covered with elevated, sharp, distinct ridges that give it an irregular, honeycomb-like appearance.

This form owes its varietal name to its occurrence near Malade, Idaho.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**5b**) *Dark blue-gray Langston limestone* [*Walcott, 1908b, p. 198*] *just above the Cambrian quartzitic sandstones, on the north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.*

(**6g**) Limestone near the base of the Middle Cambrian, the lowest horizon carrying *Paradoxides*, northwest side of Chapple Arm Harbor about a mile (1.6 km.) from its head, Trinity Bay, Newfoundland.

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[a] This species is somewhat doubtfully identified from this locality.

Micromitra (Iphidella) pannula ophirensis (Walcott).

Plate IV, figures 4, 4a–f.

Iphidella pannula ophirensis Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 306. (Characterized as a new variety.)

Surface formed by raised, concentric lines and ridges that inosculate and become more and more irregular until the typical surface of *Micromitra (Iphidella) pannula* is developed.

This form owes its varietal name to its occurrence at Ophir, Utah.

Formation and locality.—**Middle Cambrian:** (3e) Thin-bedded limestones less than 400 feet (121.9 m.) above the quartzitic sandstones of the Cambrian, near Ophir, Oquirrh Range, Tooele County, Utah.

Shells that I can not separate from this variety occur at the following localities:

Middle Cambrian: (3x) About 2,200 feet (670.6 m.) above the Lower Cambrian and 2,200 feet (670.6 m.) below the Upper Cambrian, in the limestone forming 1d of the Marjum limestone [Walcott, 1908f, p. 180], 2.5 miles (4 km.) east of Antelope Springs, in ridge east of Wheeler Amphitheater; and (11o) about 2,750 feet (838.2 m.) above the Lower Cambrian and 1,650 feet (502.9 m.) below the Upper Cambrian, in limestone at the base of 1a of the Marjum limestone [Walcott, 1908f, p. 179], about 4 miles (6.4 km.) southeast of Antelope Springs, in the spur at the junction of the Deseret and Swasey Spring roads; both in the House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah.

(54s) Dark blue-gray Langston limestone [Walcott, 1908f, p. 198], just above the Cambrian quartzitic sandstones, on the north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

(14s) About 2,300 feet (701 m.) above the Lower Cambrian and 2,700 feet (823 m.) below the Upper Cambrian, in the *Ogygopsis* zone of the Stephen formation [Walcott, 1908f, p. 210], northwest slope of Mount Stephen, above Field on the Canadian Pacific Railway, British Columbia, Canada.

Fragments of shells that are not to be separated by their surface characters from *Micromitra (Iphidella) pannula ophirensis* occur in China. The fragments also indicate that the shells were about the same size and form.

Middle Cambrian: (C5) Lower limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 39], 3.2 miles (5.1 km.) southwest of Yenchuang, Sintai district, Shantung, China.

Genus VOLBORTHIA von Möller.[a]

Volborthia von Möller, 1874, Neues Jahrb. für Mineralogie, pp. 449–452. (Described and discussed in German as a new genus; see below for free translation of description on pp. 449–451.)

Acrotreta (Volborthia) (von Möller), Oehlert, 1887, Manuel de conchyliologie, by Fischer, p. 1266. (Described in French as a subgenus, with figures of "*Acrotreta (Volborthia) recurva* (Kutorga).")

Volborthia von Möller, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 249. (Described.)

Volborthia von Möller, Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Mus. for 1891, p. 565. (Copy of preceding reference.)

Volborthia von Möller, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 95–96. (Original description, von Möller, 1874, pp. 449–451, translated essentially as below and genus discussed.)

Volborthia von Möller, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 143. (Classification of genus.)

The description in substance by von Möller [1874, pp. 449–451] is as follows:

The shells remind one in their form of a broad horn whose opening is closed through a very convex cover (the dorsal valve). Seen from above, the outline of the figured shell, in consequence of the rounded edges and the likewise rounded front edge, is transversely oval. Only the posterior edge, whose length is about one-half of the breadth of the shell, appears straight.

The ventral valve is very high, conical, and has a strong, recurved, prominent beak without any perforation. Between the beak and the hinge line (posterior edge) is a distinctly marked and high three-cornered area, whose length is divided by a narrow ridge extending from the beak to the middle of the straight hinge line.

The dorsal valve is convex, nevertheless decidedly lower than the ventral, and it has just such a beak as the other. Although this beak lies in the same vertical line with that of the opposite valve, it nevertheless touches the hinge line of the shell, without any area lying between.

The surface of both valves is smooth and covered only with very fine concentric growth striæ, which extend without interruption also over the area of the ventral valve. On the latter they appear much coarser and not so regular, especially on the ridge where these striæ are rather strongly bent downward toward the beak of the ventral valve.

Neither the ventral nor the dorsal valves appear to have inward projections; at least the casts (molds) show not the slightest traces thereof. Likewise the muscle scars are not known, and on the casts are usually found only a small

[a] Prior to the definition of *Volborthia* by von Möller [1874, p. 449] the species now referred to this genus was placed under *Acrotreta* Kutorga [1848, p. 277].

number of widely separated radial lines. As regards the substance of the shell, it must be remarked that it is exactly the same as in the genus *Siphonotreta*, i. e., calcareous-horny, and of a brown color. Under the microscope, enlarged six to eight times, the valves show a fine but distinct puncturing, invisible to the unaided eye.

As regards the dimensions of the shell, the largest examples have a length of 14, a breadth of 19, and a thickness of 16 mm., while the height of the ventral valve is 10 mm.

Hall and Clarke [1892c, p. 96] compare this genus with *Kutorgina* on account of the general form and surface characters, and call attention to the presence of an areal ridge similar to that of "*Iphidea*" = *Micromitra*. The authors were under the impression that an apical foramen existed in *Micromitra* and probably in *Volborthia* and that the areal ridge was the "ecurved" foramen scar. I do not find a foramen in *Micromitra*, and none has been seen in *Volborthia*. The areal ridge appears to be the arched pseudodeltidium, both in *Micromitra* [Pl. III, fig. 3b] and *Volborthia* [Pl. I, fig. 6e].

The previously published illustrations of *Volborthia recurva* do not show any opening between the posterior margins of the valves, but that there was an opening for the passage of the pedicle is shown in figures 33A and 33A′.

The absence of defined muscle scars and vascular markings is a characteristic of this genus.

The generic name was given in honor of Dr. A. von Volborth.

Type.—*Acrotreta recurva* Kutorga.

Volborthia recurva (Kutorga).

Text figures 33A–B; Plate I, figures 6, 6a–e.

Acrotreta recurva Kutorga, 1848, Verhandl. Russ.-kais. min. Gesell. St. Petersburg for 1847, No. 12, pp. 277–278, Pl. VII, figs. 9a and 9d. (Characterized and discussed in German as a new species. The description of Pl. VII gives the name of the species as "*Acrotreta incurva.*" The only figures accompanying the reference are those mentioned, 9a and 9d.)

Figure 33.—*Volborthia recurva* (Kutorga). A, Posterior view of specimen figured by von Möller, 1874, Pl. VII, figs. 1–6. A′, Enlargement of same to show pedicle opening, light from the right. B, Posterior view of an associated ventral valve showing crenulation of the striæ on the false area.

The specimens represented are from Locality **336g**, limestone in the vicinity of Zarskoe Selo, Russia. The specimens are now in the museum at Reval, but a cast of the type specimen represented in figures 33A–A′ is in the collections of the U. S. National Museum, Cat. No. 58298.

Volborthia recurva (Kutorga), von Möller, 1874, Neues Jahrb. für Mineralogie, pp. 449–452, Pl. VII, figs. 1–6. (The description and discussion of the species is included in that of the genus, which is in German and which is translated on pp. 355–356. Figs. 1–6 are copied in this monograph, Pl. I, figs. 6, 6a–e, respectively. The specimen represented by figs. 6, 6a–e of von Möller's paper is redrawn in this monograph, figs. 33A–A′.)

Volborthia recurva (Kutorga), Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, figs. 261 and 262, p. 249. (No text reference. Figs. 261 and 262 are copied from von Möller 1874, Pl. VII, figs. 2 and 6, respectively.)

Volborthia recurva (Kutorga), Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Mus. for 1891, figs. 261 and 262, p. 565. (Copy of preceding reference.)

Volborthia recurva (Kutorga), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 95–96, figs. 52 and 53. (The description of the species is included in that of the genus, which is translated, essentially as on pp. 355–356 of this monograph, from von Möller, 1874, pp. 449–451. Figs. 52 and 53 are copied from von Möller, 1874, Pl. VII, figs. 2 and 6, respectively.)

The generic description includes the important characters of this, the only known species.

Formation and locality.—**Ordovician**: (**336g** [*Kutorga, 1848, p. 278*]) *Limestone in the vicinity of Zarskoe Selo;* and (**337j** [Fr. Schmidt, personal communication, 1908]) zone B IIIα or B IIIβ, characterized by *Asaphus raniceps*, a little above the zone with *Asaphus expansus*, at Obuchow (Obookhov), on Wolchow River; both in the Government of St. Petersburg, Russia.

Genus HELMERSENIA Pander.

Siphonotreta JEREMEJEW, 1856, Verhandl. Russ.-kais. min. Gesell. St. Petersburg for 1855–6, No. 2, pp. 73 and 80. (New species *S. ladogensis* described in German.)

Helmersenia PANDER, 1861, Bull. Acad. imp. sci. St.-Pétersbourg, vol. 3, columns 48–49. (Jeremejew's species described and discussed in German.)

Helmersenia Pander, ZITTEL, 1880, Handbuch der Palæontologie, Bd. I, Abth. 1, p. 666. (Described in German.)

Keyserlingia KARPINSKY, 1887, Bull. Acad. imp. sci. St.-Pétersbourg, vol. 31, p. 476, footnote. (The use of *Keyserlingia* in this footnote is clearly a typographical error, *Helmersenia* being intended. The genus is discussed in German.)

Helmersenia Pander, OEHLERT, 1887, Manuel de conchyliologie, by Fischer, p. 1264. (Described in French, see p. 369.)

Helmersenia Pander, HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 254. (Described.)

Helmersenia Pander, HALL and CLARKE, 1892, Forty-fifth Ann. Rept. New York State Mus. for 1891, p. 570. (Copy of preceding reference.)

Helmersenia Pander, HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 119. (Copies Hall and Clarke, 1892a, p. 254, and discusses genus.)

Helmersenia Pander, WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 143. (Classification of genus.)

General form longitudinally ovate, subcircular to transversely ovate, with the ventral valve broadly subacuminate and dorsal valve broadly rounded except at the minute beak; ventral valve moderately convex, rising on the umbo and sloping most rapidly down to the minute, nearly marginal beak; dorsal valve gently convex with apex marginal.

The interior of the ventral valve shows a narrow area with a thickened median ridge extending a short distance forward to the visceral area. The latter has the general form of the visceral area of *Obolus*, with the muscle scars in front on each side of the center. One specimen shows the central and the outside and middle lateral scars; beneath the area, at the base of the median ridge, the main vascular sinuses arch outward and then forward; between the vascular sinus and the outer margin of the shell there are indications of the transmedian and anterior lateral muscle scars. The interior of the dorsal valve shows a slender median ridge extending well forward into the valve, and the main vascular sinuses well out toward the side of the shell. None of the specimens show the muscle scars of this valve, and I have not been able to find more than the broken margin of the area.

Surface marked by concentric striæ and a few stronger lines of growth. Scattered irregularly over the surface on the epidermal layer there are elongate bases of numerous slender spines that closely resemble the bases of the spines of *Siphonotreta verrucosa* (Eichwald). The inner surface is minutely punctate with a few larger scattered punctæ.

The shell varies in size from 2 to 3 mm. in diameter. It rarely exceeds 2 mm.

Type, *Siphonotreta ladogensis* Jeremejew.

From Pander's remarks [1861, p. 48] in describing the genus *Helmersenia* it is evident that he considered the shells described by Jeremejew [1856, p. 73] as *Siphonotreta ladogensis* as belonging to this genus. As pointed out by Karpinsky [1887, p. 476] the form studied by Pander differs from *S. ladogensis* in being more circular in outline. I strongly suspect, however, that if the types of *S. ladogensis* were compared with the material used by Pander they would be found to be specifically identical. The figures given by Jeremejew [1856, p. 73] in my opinion represent young shells of the form subsequently named by Karpinsky.

Through the courtesy of Dr. Fr. Schmidt, of the Geological Survey of Russia, I have had the opportunity of studying specimens of *Helmersenia* collected by Karpinsky at Kunitz, in the Government of Pskow. I also received from Dr. A. Mickwitz some fine specimens collected at Koporje, in the Government of St. Petersburg. With the specimens from Kunitz there somewhat rarely occurs *Keyserlingia buchi* (de Verneuil) and large numbers of *Obolus* (*Schmidtia*) *celatus* Volborth. The associated forms at Koporje are *Obolus* (*S.*) *celatus* and fragments of a larger *Obolus*.

Pander [1861, p. 48] describes the ventral valve of this species as having at the top of the beak a circular opening that does not, as in the "*Siphonotretem*," extend into a canal. I have carefully studied with a strong lens more than one hundred specimens of the ventral valve of

this species, and in only three specimens have I found what might be considered to be a perforation at the apex of the shell. In one of these it was clearly a circular fracture of the shell, and in the other two the apex had been pushed in so as to form a small circular depression with sharp edges. Several interiors of the shell also fail to show any indication of an opening through the shell; the specimen illustrated by Pander [1861, Pl. II, fig. 2b] and the enlargement (g) are very much like the specimen with the minute circular opening caused by fracture. There are several other specimens in which there is a slight depression just in advance of the beak, which indicates that the shell was very thin and slightly flexible at this point. I would not venture to suggest that this was an imperfect ventral valve were it not for the fact that I have such an abundant supply of material which is clearly to be referred to the form described by Pander. I would further state that it frequently occurs that the apex of the shell is slightly raised above the surface so as to form a minute node and that when the apex is pushed in the edge of the depression follows a concentric line of growth.

If we consider that *Helmersenia* is not a perforate shell, it then falls in with *Obolus* except that the area of the ventral valve is unlike that of *Obolus* and it has a spinose outer surface. The area, as illustrated by Pander [Pl. LXIII, fig. 7d], is of the *Mickwitzia monilifera* type (Pl. VI, fig. 1″). The shells of *Helmersenia* are delicate and much more like those of *Mickwitzia* than *Obolus*. The outer surface of *Mickwitzia* is not known to be spinose, but if we compare the surface shown by figures 1n and 2 (Pl. VI) with figures 7, 7a–b (Pl. LXIII) of *Helmersenia* we gain an impression of their great similarity. On account of the character of the area of the ventral valve, the appearance of the shell, and its surface, *Helmersenia* is placed within the Paterinidæ.

The generic name was given in honor of Grégoire de Helmersen.

Helmersenia ladogensis (Jeremejew).

Plate LXIII, figures 7, 7a–f.

Siphonotreta ladogensis Jeremejew, 1856, Verhandl. Russ.-kais. min. Gesell. St. Petersburg for 1855–6, No. 2, pp. 73 and 80, figs. 5a–c, p. 73. (Described in German on p. 80, as a new species.)

Discina buchii Eichwald (in part) [not (de Verneuil)], 1860, Lethæa rossica, ancienne période, vol. 1, sec. 2, p. 914. (Includes *Siphonotreta ladogensis* with *Discina buchii*.)

Helmersenia Pander, 1861, Bull. Acad. imp. sci. St.-Pétersbourg, vol. 3, columns 48–49, Pl. II, figs. 2a–g. (Described and discussed in German. Figs. 2d and 2f are copied in this monograph, Pl. LXIII, figs. 7d and 7c, respectively.)

Helmersenia jeremejewi Dall, 1877, Bull. U. S. Nat. Mus. No. 8, p. 31. (See the text below for discussion of this reference.)

Keyserlingia panderi Karpinsky, 1887 (April), Bull. Acad. imp. sci. St.-Pétersbourg, vol. 31, p. 476, footnote. (Discussed in German; see below.)

Helmersenia jeremejewi Dall, Oehlert, 1887 (June), Manuel de conchyliologie, by Fischer, p. 1264. (Mentioned in French as type of genus; see below.)

Helmersenia sp.? Pander, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 254, Pl. IV, figs. 6 and 7. (Mentioned in the text, which is a description of the genus. Figs. 6 and 7 are copied from Pander, 1861, Pl. II, figs. 2d and 2b, respectively.)

Helmersenia sp.? Pander, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 119, Pl. IV, figs. 4 and 5. (Mentioned. Figs. 4 and 5 are copied from Hall and Clarke, 1892a, Pl. IV, figs. 6 and 7, respectively.)

The specific description of this species has been included in the generic description.

Pander [1861, p. 48] gave no specific name to the form which he described as *Helmersenia*, but he refers to *Siphonotreta ladogensis* Jeremejew in such a manner as to indicate that he considered that species as the type.

In 1877 Dall published a list of the names applied to the subdivisions of the Brachiopoda, and [1877, p. 31] designated the type species as *Helmersenia jeremejewi*, ascribing the species to Pander and referring to page 47 of Pander's paper. Pander [1861, p. 48] places the words "*Siphonotreta* Jeremejew" after *Helmersenia*, refers to the place of publication of *Siphonotreta? ladogensis* Jeremejew, and discusses the generic relations of the specimens before him with *Siphonotreta ladogensis*. It is thus evident that Pander did not name the species *H. jeremejewi*.

Dall tells me that he did not see Jeremejew's paper in which the specific name *ladogensis* was proposed.

Ten years later Karpinsky [1887, p. 476], in his report on the Geology of the Government of Pskow, gives a list of the species occurring in the *Ungulite* sandstone and places a footnote after the word *Helmersenia*, in which he refers to "*Keyserlingia*" and suggests that the species be called "*Keyserlingia panderi.*" In this footnote he mentions "*Keyserlingia*" three times, but places after the first a reference to Pander's description of *Helmersenia*. It is evident that Karpinsky intended to specifically identify *panderi* with *Helmersenia* and not *Keyserlingia*.

A few months after the appearance of Karpinsky's paper Oehlert, in Fischer's Manuel de Conchyliologie, describes the genus *Helmersenia* [1887, p. 1264] and gives as the type *H. jeremejewi* Pander. He gives no reference, but it is likely that he followed Dall.

This form owes its specific name to its occurrence near Ladoga, near St. Petersburg, Russia.

FORMATION AND LOCALITY.—**Upper Cambrian:** (336o) Ungulite grit, Koporje, Government of St. Petersburg; (336p) Ungulite grit, Kunitz, Government of Pskow; and (336q [*Jeremejew, 1856, pp. 73 and 80*]) *Ungulite sandstone, near Ladoga, Government of St. Petersburg;* all in Russia.

Superfamily OBOLACEA Schuchert.

Family CURTICIIDÆ Walcott and Schuchert.

Genus CURTICIA Walcott.

Curticia WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 319. (Mentioned as below as a new genus.)
Curticia WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 143. (Classification of genus.)

The description of the type species, *Curticia elegantula*, includes all that is known of this genus.

The generic name is given in recognition of the excellent work of Dr. Cooper Curtice, of Moravia, New York, both as a field collector and laboratory assistant.

CURTICIA ELEGANTULA Walcott.

Plate I, figures 2, 2a–l.

Curticia elegantula WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 319–320. (Described and discussed as below as a new species.)

General form subcircular, biconvex. Surface of exterior of shell marked by fine, concentric, slightly undulating striæ, and lines and varices of growth. When the thin exterior layer is exfoliated, the inner layers are ornamented by numerous fine, radiating lines, very much as in *Dicellomus* and *Obolus*, also by more or less imbricating concentric lines. The inner surface shows radiating and concentric lines without the visceral area. Shell substance corneous and probably calcareous. The shell is built up of a thin, outer, surface layer and several inner layers or lamellæ, slightly oblique to the outer surface on the umbo and central parts of the valves. The lamellæ are more oblique and numerous toward the front and sides, and thus thicken the shell over those parts. The average ventral valve has a length of 5 mm.; width, 6 mm.; dorsal valve, 5 mm. by 5 mm.

Ventral valve strongly convex, most elevated at the umbo, and arching over to a minute, slightly incurved apex; area rudimentary, with a high, triangular, open delthyrium occupying most of it. A cast of the interior of the valve shows that a narrow, elevated ridge occurs just in advance of the apex, and a very small visceral area is indicated.

Dorsal valve evenly convex, apex marginal; cardinal area rudimentary, narrow, and divided by a low, broad, open delthyrium. The interior shows a median ridge and septum, with small rounded depressions beneath the umbo on each side of the median ridge and a little in advance of the apex. Ventral muscle scars small and clearly defined. Anterior lateral scars small and situated in advance of the central scars close to the median ridge and at its anterior extremity. Main vascular sinuses broad and slightly defined.

Observations.—This shell was labeled by the field collector as *Dicellomus politus*. In external form it resembles that species, but the open delthyrium of the ventral valve and the

absence of an area on the dorsal valve distinguish it. It appears to be a form intermediate in development between *Rustella*, with its absence of cardinal areas and its very rudimentary pedicle aperture, and *Obolus*, with its well-defined cardinal areas with their pedicle grooves. It occurs in large numbers and its dark smooth shell is a very striking object in the buff-gray sandstone.

FORMATION AND LOCALITY.—**Upper Cambrian: (82b)** "St. Croix sandstone" along the railroad track near Taylors Falls, Chisago County, Minnesota.

Family OBOLIDÆ King.

Subfamily OBOLINÆ Dall.

Genus OBOLUS Eichwald.[a]

[ὀβολός, a coin.]

Obolus EICHWALD, 1829, Zoologia specialis, vol. 1, p. 274. (Described in Latin as a new genus.)

Unguliten PANDER, 1830, Beiträge zur Geognosie des russischen Reiches, pp. 55–58. (Described and discussed in German.)

Ungula PANDER, 1830, idem, pp. 57–58. (Proposed as a new genus on p. 57 and described in German.)

Ungulites QUENSTEDT, 1837, Archiv für Naturgeschichte, von A. F. A. Wiegmann, Jahrg. 3, Bd. 1, pp. 143–145. (Refers to Pander's new genus *Ungula* as "*Ungulites*" and describes the genus in German.)

Orthis VON BUCH (in part), 1841, Archiv für Mineralogie, Bd. 15, Hft. 1, p. 7. (Merely describes and discusses *Obolus apollinis* as "*Orthis ungula*," and refers the species to the "*Unguliten*," the text being in German.)

Unguliten Pander, VON BUCH, 1841, idem, p. 7. (The description of this group is incorporated with that of the species "*Orthis ungula*" (*Obolus apollinis*), the text being in German.)

Obolus Eichwald, DE VERNEUIL, 1845, Géologie de la Russie d'Europe, by Murchison, de Verneuil, and de Keyserling, vol. 2, pt. 3, p. 291. (The genus is discussed in French in the third and fourth paragraphs on p. 291, under *Obolus apollinis;* see Matthew, 1892, pp. 43–44, for translation.)

Obolus Eichwald, KUTORGA, 1848, Verhandl. Russ.-kais. min. Gesell. St. Petersburg for 1847, No. 12, pp. 250–253. (Discussed in German.)

Aulonotreta KUTORGA (in part), 1848, idem, pp. 278–279. (Described in German as a new genus, the species in the genus belonging with *Obolus*, *Obolus* (*Acritis*), and *Obolus* (*Mickwitzella*).

Obolus Eichwald, MORRIS, 1849, Annals and Mag. Nat. Hist., 2d ser., vol. 4, pp. 319–320. (Discussed.)

Obolus Eichwald, DAVIDSON (in part), 1853, British Fossil Brachiopoda, vol. 1, introduction, No. 3, pp. 135–136. (Described and discussed. The species referred to the genus belong with *Obolus*, *Obolus* (*Acritis*), and *Obolus* (*Mickwitzella*). Two of the species, *Obolus davidsoni* and *Obolus transversa*, are Ordovician forms and are not taken up in this monograph.)

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[a] The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Obolus* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record for the species taken up in the monograph the following mere generic references are listed:

Obolus von Leuchtenberg [1843, p. 16].
Orbicula Owen [1852, p. 583].
Lingula Billings [1859, p. 431].
Obolus Schmidt [1861, p. 218].
Lingula Billings [1863, p. 124].
Lingulepis Hall [1863, pp. 129 and 130].
Lingula Billings [1865a, p. 216].
Obolus? Billings [1865b, p. 362].
Lingulepis Hall [1867, p. 107].
Lingula Barrande [1868a, p. 100].
Obolus? Barrande [1868a, pp. 104 and 105].
Lingula Barrande [1868b, p. 690].
Obolus? Barrande [1868b, p. 693].
Lingulella? Meek [1871, p. 185].
Obolus Billings [1872a, p. 218; 1872c, p. 356].
Obolus Kayser [1876, p. 9].
Obolus Roemer [1876, Pl. II, figs. 7a–c].
Obolella Hall and Whitfield [1877, p. 205].
Lingulepis Hall and Whitfield [1877, p. 206].
Lingula Barrande [1879b, Pls. CVI: IV; CX: VIII; CXI: I, and CXI: VI].
Obolus? Barrande [1879b, Pls. XCV: IV; CXI: VI; CXIII: V; CXXVI: II; and CLII: II].
Obolus Noetling [1883, p. 265].
Lingulella Kayser [1883, p. 35].
Lingulepis Walcott [1884b, p. 12].
Obolella Walcott [1884b, p. 14].
Obolus Roemer [1885, p. 23 (270)].
Obolella? Walcott [1886b, p. 111].
Lingulella Walcott [1889c, p. 441].
Obolus Gagel [1890, p. 21].
Lingula Bornemann [1891, p. 438].
Obolella Bornemann [1891, pp. 439 and 440].
Lingulella? Hall and Clarke [1892c, p. 61].
Obolella?? Hall and Clarke [1892c, pp. 69 and 73].
Lingulella Keyes [1894, p. 38].
Lingulella Matthew [1895b, p. 255].
Lingula Sardeson [1896, p. 95].
Schmidtia Mickwitz [1896, p. 19].
Glossina Schuchert [1897, p. 224].
Lingulella? Walcott [1897a, p. 404].
Obolus (*Lingulella*) Walcott [1898b, pp. 404, 412, 415, 416, 418, and 419; 1899, pp. 443 and 445; 1901, p. 673].
Obolus Walcott [1901, p. 684].
Obolus Matthew [1902c, pp. 94 and 96].
Obolus (*Monobolina*) Matthew [1902e, p. 98].
Lingulella Matthew [1902c, p. 108].
Obolus (*Lingulella*) Walcott [1902, p. 605].
Lingulella Matthew [1903, p. 62].
Obolus Matthew [1903, p. 76].
Monobolina Matthew [1903, p. 210].
Obolus Walcott [1905a, pp. 324, 325, 326, 327, and 328].
Obolus (*Lingulella*) Walcott [1905a, pp. 328, 330, and 331].
Obolus Moberg and Segerberg [1906, p. 65]
Obolus Walcott [1908c, p. 244; 1908d, pp. 61, 62, and 63].

Obolus Eichwald (in part), 1860, Lethæa rossica, ancienne période, vol. 1, sec. 2, pp. 924–925. (Described in French. The species referred to the genus belong with *Obolus*, *Obolus* (*Acritis*), and *Obolus* (*Mickwitzella*).)

Obolus Eichwald, Davidson, 1866, British Fossil Brachiopoda, vol. 3, pt. 7, No. 1, p. 58. (Gives synonymy and refers genus to Lingulidæ.)

Not *Schmidtia* von Volborth, 1869, Verhandl. Russ.-kais. min. Gesell. St. Petersburg, 2d ser., pt. 4, pp. 208–209. (Characterized and discussed as a new genus to include those forms which had been referred to *Ungula*, but which were not included in *Ungulites* Quenstedt, 1837, p. 143. *Schmidtia celatus* is, however, described as the only representative of the new genus.)

Obolus Eichwald, Dall, 1870, Am. Jour. Conchology, 2d ser., vol. 6, pt. 2, pp. 154 and 162. (Described.)

Ungula Pander, Dall, 1877, Bull. U. S. Nat. Mus. No. 8, p. 75. (Discusses date of publication of *Ungula* Pander, *Ungula* Rose, and *Obolus* Eichwald.)

Obolus Eichwald, Zittel, 1880, Handbuch der Palæontologie, Bd. 1, Abth. 1, p. 664. (Described in German.)

Obolus Eichwald, Davidson, 1883, British Fossil Brachiopoda, vol. 5, pt. 2, p. 218. (Mentioned in discussion of *Siphonotreta*.)

Ungulites Quenstedt, 1885, Handbuch der Petrefactenkunde, Aufl. 3, p. 756. (Characterized in German.)

Obolus Eichwald, Oehlert, 1887, Manuel de conchyliologie, by Fischer, p. 1261. (Described in French, with figures of "*O. davidsoni* Salter" and "*O. politus* Kutorga.")

Obolus Mickwitz, 1892, Mélanges géol. et paléontol. tirés du Bull. Acad. imp. sci. St.-Pétersbourg, vol. 1, pp. 57–64. (Described and discussed in German.)

Obolus Matthew, 1892, Trans. Roy. Soc. Canada, 1st ser., vol. 9, sec. 4, No. 5, pp. 43–44. (Translates the description given by de Verneuil, 1845, p. 290.)

Obolus Eichwald, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, pp. 242–243. (Described and discussed.)

Aulonotreta Kutorga, Hall and Clarke (in part), 1892, idem, pp. 243–244. (Described and discussed. As discussed the genus includes species referred to both *Obolus* and *Obolus* (*Acritis*).)

Obolus Eichwald, Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Museum, for 1891, pp. 558–559. (Copied from Hall and Clarke, 1892a, pp. 242–243.)

Aulonotreta Kutorga, Hall and Clarke (in part), 1892, idem, pp. 559–560. (Copied from Hall and Clarke, 1892a, pp. 243–244.)

Obolus Eichwald, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 80–81. (Described and discussed.)

Aulonotreta Kutorga, Hall and Clarke (in part), 1892, idem, p. 82. (Described and priority of generic references, etc., discussed. As discussed the genus includes species referred to both *Obolus* and *Obolus* (*Acritis*).)

Obolus Eichwald, Hall and Clarke, 1892, idem, pp. 337–339. (Gives a translation of Mickwitz's diagnosis, 1892, and discusses genus.)

Obolus Eichwald, Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 1–133. (These pages contain a general discussion of the genus and its relations, in German, the actual diagnosis of the genus being given on pp. 127–129.)

Obolus (*Euobolus*) Mickwitz, 1896, idem, pp. 129 and 133. (Characterized in German, on p. 129, as a new subgenus.)

Obolus Eichwald, Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 385–386. (Genus and type species discussed.)

Obolus Eichwald, Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 681–683. (Described and discussed, translating a portion of Mickwitz's description, 1896, pp. 118–121.)

Obolus Eichwald, Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 135. (Characterized and discussed.)

Obolus (*Eobolus*) Matthew (in part), 1903, idem, pp. 135–136. (Characterized as a new subgenus. One of the three species referred to the subgenus belongs with *Obolus* and the remaining two belong with *Lingulella*.)

Obolus Eichwald, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 144. (Classification of genus.)

Diagnosis (mainly after Mickwitz [1896]).—Shells nearly equivalve, equal-sided, moderately convex, subcircular, transversely or longitudinally ovate, in some species subtriangular or subrectangular.

Shell substance calcareocorneous, structure foliated; the layers of calcium phosphate alternating with homogeneous, horny lamellæ are traversed by microscopic canals, which in their main direction are perpendicular to the plane of stratification; the inner layers and lamellæ are more or less oblique to the thin outer layer over the central and posterior portions of the valves, and strongly so with the short lamellæ of the anterior and lateral parts. Surface shining as if varnished, with concentric and usually radial striation, varying from bare visibility to deeply incised concentric folds and radial ribs. Color of shell dark grayish blue to black, when in a state of decomposition dark reddish brown to whitish. Front and side margins usually thin, sharp-edged, fragile, lying in the same plane with the hinge margin, which is greatly thickened inside. Area mainly in the plane of the edge of the valve, in the ventral valve triangular, owing to the somewhat projecting beak, in the dorsal valve rounded at the point,

in both striated parallel to the base, and traversed, from the point of the beak on, by the more or less diverging lines of folding of the areal lamellæ and a strongly marked pedicle furrow.

Visceral area (splanchnocœle) on the ventral valve restricted to the back part, in the dorsal valve drawn far forward into the vascular area (brachiocœle) and strongly indented laterally; in both valves it extends backward up close to the base of the visceral (splanchnocœlic) part of the area, which is bounded by the flexure line (folding of the area lamellæ). The edge of the mantle of the beak part is restricted to the side areas (pleurocœles), appearing between the flexure lines of the area lamellæ.

Anterior part of the thickened posterior half of valve slopes down to the middle of the valve, forming in the ventral valve a line concave to the beak, in the dorsal valve a sinus. The lateral parts of the thickening are drawn out into thin side edges. In front of the base of the area is a small median septum, which in the dorsal valve for the most part is less prominent, but in both is often hardly perceptible by reflected light as an almost invisible crest. Beginning at the median septum, there are in each valve two gradually deepening grooves for the main vascular canals, which intersect the thickened part parallel to the edge of the shell. In the dorsal valve these grooves combine with the sinus from the calcareous ridge in forming two projections pushing themselves like horns into the middle of the valve. The traces of the main vessels of the mantle lobes in the continuation of the visceral (splanchnocœlic) vascular grooves are subparallel and project into the vascular (brachiocœlic) parts of the valves, in the ventral valve terminating with their anterior ends in the peripheral vascular canal, in the dorsal valve, shortly before reaching the vascular canal, bending about into the interior of the shell, and vanishing at the scars of the anterior lateral muscles. The peripheral vascular canals in both valves run along their edge from one side area (pleurocœle) to the other. Traces of secondary vessels radiate in great number from the grooves of the main vessels toward the peripheral canals and into the middle of the shell.

In the median line of the ventral valve, between the median septum and the anterior edge of the thickened part of the shell, there is a deep, heart-shaped pit, with its point directed forward and having a shallow median groove. In the cavity of the dorsal valve there is a more or less pronounced median ridge, extending into the anterior part of the valve and divided longitudinally by a shallow median furrow.

On each valve there are six pairs of muscular scars, and in the ventral valve in front of the pedicle furrow there is the unpaired scar of the pedicle muscle. The umbonal scars are close to the base of the area, in the ventral valve divided, inclosing the scar of the pedicle muscle between them, in the dorsal valve confluent in the median line of the valve. The scars of the central pair of muscles are placed about centrally in both valves; in the dorsal one they are isolated on the inner sides of the ends of the hornlike projections; in the ventral valve they are united with the scars of the outside and middle lateral muscles, on both sides of the anterior part of the heart-shaped pit. The transmedian muscles are undivided; their scars in both valves are close to the base of the area in the line of prolongation of the flexure lines. The anterior lateral muscle scars of the ventral valve adjoin the transmedians, overlapping them a little on the outside; in the dorsal valve they are isolated, pushed far forward toward the frontal margin and situated at the anterior end of the median crest separating them. The scars of the second pair, the middle lateral muscles, in the ventral valve are combined with those of the central and outside lateral muscles at the point of the heart-shaped pit; in the dorsal valve they blend with those of the outside lateral muscles and lie against them on the inner sides of their anterior ends. Finally the scars of the third pair, the outside lateral muscles, in the ventral valve are combined with those of the central and middle lateral muscles and lie on the outer sides of the former, while in the dorsal valve they are united with those of the middle lateral muscles and lie obliquely outward before the scars of the transmedian muscles. In both valves the parietal band closely circumscribes all muscle scars externally, crossing the furrows of the main vessels and entering the visceral (splanchnocœlic) part of the area at its base on a line with the flexure lines.

The study of a series of the interior of the ventral valve of *Obolus apollinis* (Pl. VII) shows that the arrangement of the point of attachment of the middle (k) and outside (l) laterals and

central muscle scars (h) varies considerably in the different specimens. Mickwitz's diagrammatic figure shows the middle lateral scars (k) to be the smaller and situated close to the median line. This, however, is not the case in all specimens. In Plate VII, figure 9, the middle lateral (k) is the larger and the two other scars are arranged quite differently from those in Mickwitz's diagrammatic figure. In Plate VII, figure 5, the growth of the shell has crowded all three of the muscle scars so that they are arranged in transverse lines. In Plate VII, figure 4, they occur up on the side of the visceral cavity (v), the central scars (h) occupying the greater portion of the space, the outside laterals (l) being crowded forward, and the middle laterals (j), which are so large in figure 9, are scarcely to be determined at the inner angle in figure 4. In Plate VII, figure 3, the points of attachment of the scars are on a ridge, and they present no points of similarity to the position assigned in the diagrammatic figure of Mickwitz, nor to the positions in Plate VII, figures 9, 4, and 5. The points of attachment are sunk deep into the ridge, and on this account it is impracticable to distinguish between the central (h) and middle lateral (k) scars. In figure 1 the scars are also on a high ridge. They are slightly depressed and apparently range very much as in Plate VII, figure 5, except that the middle laterals (k) are nearer the median line. It does not appear to be possible to distinguish the centrals.

Type.—O. apollinis Eichwald.

Observations.—It is stated by Hall and Clarke [1892c, p. 339] that Mickwitz did not obtain his results from the type specimens of *Obolus apollinis*, but from a hitherto undescribed form, *Obolus quenstedti*. This is true [see Mickwitz, 1890, p. 60, footnote], but in his final work [1896, p. 128] Mickwitz diagnoses the genus and cites *Obolus apollinis* as the type. He says [1896, p. 25]:

> A more accurate study of the greatly increased material has convinced me that *O. quenstedti* can not be maintained as a species, since it is merely the terminal link of a series of variations which, like var. *maximus* and *ingricus*, can be traced back to *O. apollinis*. Thus, the typical species remains *O. apollinis* Eichwald.

Mickwitz [1896] has given in his exhaustive memoir on *Obolus* a very complete historical sketch and full description of the genus and its subgenera so far as known to him. The study was conducted with such care and thoroughness and the material was so well preserved that our present knowledge of the adult shell of *Obolus* is nearly as complete as that of the adult shell of the recent *Lingula*. The student is referred to the memoir of Mickwitz for the literature, history, and geology of the Cambrian formations of the eastern Baltic region of Russia, for a minute description of the external and internal characters of the shells of the Baltic species of *Obolus* and of the relations of *Obolus* to *Lingula* and *Obolella*, and for detailed observations on *Obolus* and its subgenera as known to him.

Obolus and Lingula.—After studying the species from American rocks and a very good series from the typical localities in Russia, I am not prepared to agree with Mickwitz that *Obolus* should be referred to the Lingulidæ. In figure 34 the interior of the valves of *Obolus* and *Lingula* may be compared.

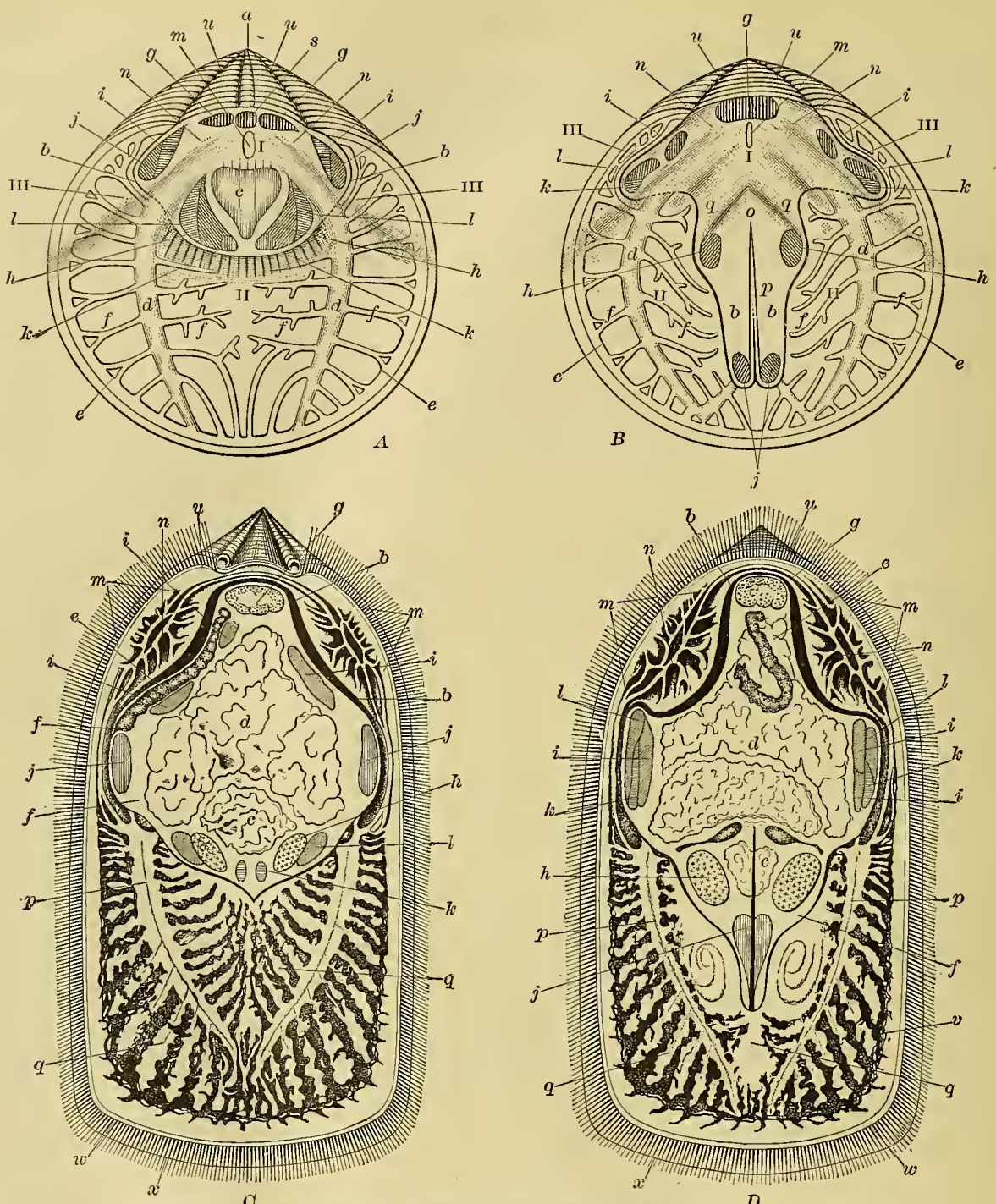

FIGURE 34.—Interiors of valves of *Obolus* and *Lingula*.

Obolus apollinis quenstedti Mickwitz. After Mickwitz [1896, figs. 6a–b, p. 79]. A, Ventral valve; B, dorsal valve.

I. Splanchnocœle.
II. Brachiocœle.
III. Pleurocœle.
a. Pedicle furrow.
b. Parietal band.
c. Heart-shaped pit.
d. Canals of principal vessels.
e. Peripheral vascular canal.
f. Secondary vascular canals.
g. Umbonal muscle.
h. Central muscles.
i. Transmedian muscles.
j. Anterior lateral muscles.
k. Middle lateral muscles.
l. Outside lateral muscles.
m. Median septum.
n. Lateral septa.
o. Sinus.
p. Median ridge.
q. Hornlike projections.
s. Pedicle muscle.
u. Flexure lines of area lamellæ.

Lingula anatina Bruguière. After King [1873, Pl. II, figs. 1 and 2]. C, Ventral valve; D, dorsal valve.

b. Parietal band which bounds the splanchnocœlic chamber in both valves.
c. Liver.
d. Genitalia.
e. Intestine.
f. Termination of intestine.
g. Umbonal muscle.
h. Central muscles.
i. Transmedian muscles.
j. Anterior lateral muscles.
k. Middle lateral muscles.
l. Outside lateral muscles.
m. Pleurocœles.
n. Vessels of pleurocœles (exaggerated).
p. Primary vessels of brachiocœle.
q. Secondary vessels of brachiocœle (those passing from the inner side of the primaries may be called ingoers and those on the outer side outgoers).
u. Setal band (the pedicle is not represented, as it would obscure the continuation of this band in the rostral region).
v. Inner edge of setal band (answering also to the line of vascular constriction).
w. Outer edge of setal band.
x. Setæ.

The points of similarity between *Obolus* and *Lingula*, as described by Mickwitz, are:

1. Chemical constitution and microscopic structure.
2. Position of the umbonal muscle in the dorsal valve.
3. Arrangement of the vessels of the circulatory system. Mickwitz [1896, p. 121] says:

Issuing between the same muscle scars (j–l, h in the ventral valve; l, i, k–h in the dorsal valve) from the splanchnocœle, two main vessels extend in each valve into the fore part of the mantle lobes and branch inward and outward into numerous secondary vessels. The only difference in the arrangement of the vessels consists in this, that in *Lingula* the main vessels of the two valves empty into the peripheral canal, while in *Obolus* this takes place only in the large valve. In the dorsal valve the main vessels, shortly before reaching the peripheral canals, bend into the interior of the valves and end at the scars of the anterior lateral muscles.

4. General arrangement of the muscle scars. These are essentially the same, the points of difference being of a generic character.

The points of difference between the two genera are:

1. The areas of the valves.
2. Attachment of the pedicle muscle. In *Lingula* the muscle is attached back of the scar of the umbonal muscle of the ventral valve, whereas in *Obolus* it is situated between the divisions of the scar of the umbonal muscle of the ventral valve.
3. Bipartition of certain muscles. Mickwitz says [1896, pp. 118–121]:

Besides the somewhat unlike arrangement of some scars, to which we shall presently return, the bipartition of certain muscles constitutes the most characteristic difference in the internal organization of the two genera. The umbonal muscle of *Obolus*, which is divided in the ventral valve [gg, fig. 34A], is undivided in *Lingula* [g, fig. 34C] while conversely the two transmedian muscles of *Lingula* [ii, fig. 34C], one of which is divided throughout its length, are represented in *Obolus* by a pair of undivided muscles [i, fig. 34A].

The position of the umbonal muscle is the same in the two genera; at most it is somewhat crowded away from the base of the area in *Lingula*, because of the pedicle muscle. On the contrary, the transmedian muscles, besides their bipartition, present other differences. In *Obolus* the scars of that pair of muscles on the ventral valve are combined with those of the anterior lateral muscles [ij, fig. 34A], while in the corresponding shell of *Lingula*, though lying in a similar position, they are separated from the anterior lateral muscles. With the dorsal valves the case is reversed. *Obolus* shows the scars of the pair of muscles in question isolated [i, fig. 34B], while in *Lingula* they are united with those of the middle and outside lateral muscles [i, k, and l, fig. 34D].

The scars of the two last-named muscles on the dorsal valve of *Obolus* [k and l, fig. 34B] are combined in a manner analogous to those of *Lingula*, so that the whole difference in the arrangement of the scars in question (aside from the bipartition of one transmedian muscle in *Lingula*) consists in the reversal of their combination. In *Obolus*, on the ventral valve, the scars i and j are united, in *Lingula* they are separated; in *Lingula*, on the dorsal valve, i k, and l are united, while in *Obolus* they are separated.

The scars of the anterior lateral muscles of the dorsal valve have a closely similar position in the two genera, except that in *Obolus* they are moved farther forward and are separated by the median ridge (p), while in *Lingula* they are nearer to the center of the valve and are united [j, fig. 34D].

The other scars of the lateral muscles on the ventral valve of *Obolus* also are quite analogous in their position to the corresponding scars in *Lingula* [k, l, fig. 34C]. True, in their case also small displacements and changes of form occur, but yet I am unable to attach to these any special value. The two genera show the scars of the outside lateral muscles [l, figs. 34A and 34C] combined with those of the central muscles [h, figs. 34A and 34C], but we have seen that in some species of the genus (*O. triangularis*, *O. panderi*, and some species of the subgenus *Schmidtia*) the first-named scars are separate from those of the central muscles and change their subtriangular form, being drawn out backward into a rounded form, more like that in *Lingula*. The scars of the middle lateral muscles (k) of the ventral valve, on the contrary, are only in Eichwald's genus combined with those of the central muscles (h), while in *Lingula* they are separated. It is probable, however, that some species of the above-named subgenus share this peculiarity with *Lingula*.

Finally, the scars of the central muscles of the two genera differ merely by their somewhat different form in the ventral valve and by their somewhat different position to the axis of symmetry on the dorsal valve. It was pointed out, however, in speaking of the central muscles of *Obolus* that the backward-protracted points of the subtrapezoidal scars in the ventral valve of the typical species (as well as those of the outside lateral muscles) are lacking in the species of the subgenus *Schmidtia*, so that even in regard to form there is an agreement with *Lingula*. In the dorsal valve of *Obolus* the elliptic scars of the central muscles are parallel to the major axis of the valve or somewhat converging behind [h, fig. 34B], while in *Lingula* they are strongly convergent anteriorly [h, fig. 34D].

To the altered position of the muscle scars in *Obolus* corresponds the modified form of the parietal band. The latter in both valves of *Lingula* is rhombic, but in the dorsal valve it is drawn farther forward than in the ventral [fig. 34D].

In *Obolus* the parietal band on the dorsal valve extends still farther toward the frontal edge than in *Lingula*, and in its posterior part is more markedly bent inward from both sides, producing a characteristic unequally three-lobed figure [fig. 34B]. The parietal band of the ventral valve of *Obolus* on the contrary is subelliptical in form, and rather approaches that of *Lingula*.

More important than this difference in form of the splanchnocœle is the difference in the form of the mantle lobes which is manifest from the position of the posterior part of the parietal band. In *Lingula* the parietal band is moved away from the base of the area and thus constitutes a narrow space between the two pleurocœles, which space is occupied by the mantle lobes that extend around the entire beak part of the valves. These mantle lobes of the beak are in the dorsal valve also covered with mantle bristles, while the border of the mantle of the ventral valve in the splanchnocœlic part of the area (deltidium, King) is free from bristles [fig. 34C]. In *Obolus* on the contrary the posterior part of the parietal band is close to the base of the splanchnocœlic part of the area, whose lamellæ, as we have seen, are bent up at right angles to the plane of the valve and therefore could not have been deposited by mantle lobes resting against the valves. Hence the mantle lobes of *Obolus* extended only as far as the pleurocœles, and were lacking, as well as the mantle bristles, in the splanchnocœlic part of the area of both valves. At that point there was only the muscular wall of the body connecting the two valves, from which the pedicle emerged.

I think that the differences pointed out are sufficient to distinguish *Obolus* as of distinct family relations from *Lingula*, but I must at the same time admit that the transitions from *Obolus* to *Lingulella* and from *Lingulella* to *Lingula* are so clearly indicated that it is only by a somewhat arbitrary decision that species of *Lingulella* like *L. bella* (Pls. XIX and XXXVI) can be referred to the Obolidæ. Schuchert [1893, p. 360] creates the family Lingulellidæ for *Lingulella* and allied forms.

Obolus and Obolella.—Authors have compared *Obolella* with *Obolus*, and Mickwitz [1896, p. 129] thought that they might possibly be congeneric. The discovery of a pedicle opening at the beak of the ventral valve of *Obolella* places the latter with the Acrotretidæ.

Criteria of subgenera.—The criteria upon which the subgenera of *Obolus* have been founded are largely based on the form of the outline of the valves, character of outer surface, thickness of shell, and, to a more limited extent, the muscular and vascular markings on the interior of the valves. I was at first inclined to give considerable weight to the position of the sinuses occupied by the main vascular canals, but further study showed such a gradation in the various species that efforts to use the character in subgeneric classification were abandoned. The following table illustrates some of the variations in the position of the vascular sinus, and many more may be found in the figures of *Obolus* and its subgenera than are indicated in the table below:

Variation in the position of the vascular sinus of Obolus and its subgenera and Lingulella.

[Roman numerals indicate plates and arabic numerals figures.]

Species.	Distance of sinus from center to lateral margin.			
	Less than one-half distance.	One-half distance.	Two-thirds distance.	Three-fourths distance.
Obolus:				
apollinis	VII: 14	VII: 1, 2, 4, 8, 11	VII: 6, 7	
apollinis maximus	XIV: 7a			
complexus			XII: 3a	
cyane			XXVII: 4, 4a	
feistmanteli	XII: 1c, 1d	XII: 1e	XII: 1b	
lamborni			XXII: 2b, 2k	XXII: 2j, 2g.
matinalis		VIII: 1d, 1e, 1f, 1g, 1h.		
mickwitzi		X: 1i, 1j, 1k	X: 1, 1a, 1b	
namouna	VIII: 2, 2a			
prindlei		XXVII: 3a		
rhea		IX: 1, 1a		
? rokitzanensis			XII: 6	
schmidti		XV: 11		
sinoe	XXVI: 2d	XXVI: 2a	XXVI: 2e	
willisi		XXIII: 1, 1a		
Obolus (Bröggeria):				
salteri	XIII: 1e			XIII: 1j, 1m
Obolus (Schmidtia):				
celatus		XIV: 1a	XIV: 1c	
crassus			XIV: 4d	XIV: 4c.
obtusus			XIV: 3a	
Obolus (Westonia):				
ella		XLVII: 1d, 1k, 1 l, 1n.	XLVII: 1c, 1g	
escasoni		XLIX: 1, 1a	XLIX: 1c	
euglyphus			XLVIII: 1d	
rogersi			XLII: 2a, 2b	

Variation in the position of the vascular sinus of Obolus and its subgenera and Lingulella—Continued.

Species.	Distance of sinus from center to lateral margin.			
	Less than one-half distance.	One-half distance.	Two-thirds distance.	Three-fourths distance.
Lingulella:				
ampla		XXVIII: 1e	XXVIII: 1d, 1f, 1g	
atava		XXXV: 5a, 5b		
auga			XXIV: 6c	
cania		XXXV: 3b		XXXV: 3a.
davisi			XXXI: 6f	
desiderata		XX: 4b, 4c		
dubia			XXIV: 4	
ferruginea		XXIX: 1l	XXIX: 1o	
grandis		XXXVIII: 2c, 2d		
granvillensis				XXII: 1d.
hayesi		XXV: 1b	XXV: 1c	XXV: 1g, 1h, 1i.
helena		XXIV: 3a, 3b		
ino			XXVI: 4	
irene			XXVII: 6	
leos				XXIV: 2a.
manticula		XX: 1		
mosia			XVIII: 1a, 1c	
nathorsti			XXXI: 1	
phaon			XXVI: 1b, 1d, 1e	
prima		XXVII: 1		
radula	XLV: 1e	XLV: 1, 1c, 1h, 1i	XLV: 1a, 1j 1k, 1l	
similis			XXI: 2, 2a	
tarpa		XXIII: 2a	XXIII: 2	
winona convexa			XVIII: 4a	
Lingulella (Lingulepis):				
acuminata		XLII: 1g, 1h; XLI: 1a	XLII: 1e	
exigua		XLIII: 1s, 1u	XLIII: 1x, 1y	
gregwa		XLIV: 1k		XLIV: 1n.

Subgenera of Obolus.—*Acritis* Volborth [1869, p. 212] is ornamented with concentric lines which are elevated, irregular, and undulating. The valves are strongly arched and massive; the visceral area (splanchnocœle) small and short, and the pedicle furrow conical and deeply impressed in the cardinal area. Type: *Obolus* (*Lucina*) *antiquissimus* Eichwald (Pl. XIII, fig. 3, and Pl. XV, figs. 1, 1a–c).

Bröggeria Walcott [1902, p. 605] has the typical ovate outline of *Obolus*, but differs from *Obolus* and its other subgenera in having a very deep visceral depression (splanchnocœle) in both valves, and in its minutely papillose interior surface. Type: *Obolella salteri* Holl (Pl. XIII, figs. 1, 1a–n, and Pl. XV, figs. 4, 4a–d).

Eoobolus Matthew [1903, p. 135] was proposed for certain species of *Obolus* in which the central muscle scars and anterior scars were arranged in a more or less quadrate manner, as in *Obolus selwyni* (Matthew) (Pl. XXXVI, figs. 2a and 2b). I find that the specimen illustrated by Matthew [1903, Pl. VIII, fig. 2d] was distorted. It is figured in Plate XXXVI of this monograph (fig. 2a), and a second distorted specimen in figure 2b. A more perfect specimen is illustrated in figure 1g, and the changes in position of the muscle scars in the center of the dorsal valve may be seen by comparing Plate XXXVI, figures 2a and 1g; Plate XXXVII, figure 1c; Plate XXVIII, figures 1h and 1g; Plate XXXI, figure 6e; Plate XVII, figures 1h and 1j; Plate XXI, figure 2a. A study of the figures cited and many others shows that the position of the central muscle scars and anterior lateral scars is not a character of sufficient importance and value upon which to found a subgenus of *Obolus*. On this account *Eoobolus* is considered as a synonym of *Obolus*.

Euobolus Mickwitz [1896, p. 314] was elaborately described as a subgenus of *Obolus* by Mickwitz, who referred to it all species showing radial striation. He says [1896, p. 128]:

> In grouping the species by their distinctive marks, two great divisions become apparent. One of them shows, besides the concentric striation of the outer surface of the shell, peculiar to all *Obolus* species, also a radial striation which is lacking in the others. Thus, while the concentric striation is a general characteristic, which, nevertheless, by differences in development, furnishes useful specific features, the radial striation, due to a different condition of the edge of the mantle (no matter whether this be due to the mantle bristles or to the circulatory vessels), constitutes a group character. For this reason all radially striated Oboli, whose other characters also show a certain agreement in other respects, were united into a subgenus *Euobolus*. Furthermore, the concentric striæ of certain species showed remarkable variations, which also indicate a peculiar organization of the edge of the mantle. The species *O. silurieus* and *antiquissimus* show this striation running parallel on the growth lamellæ corresponding to a period of vegetation,

while in all other *Obolus* species they converge. As the species mentioned differ from each other considerably in other respects, it seemed to me necessary to assign them to special subgenera, *Thysanotos* and *Acritis*. The remaining species also fall into two groups differing from each other in many ways, one of them, *Schmidtia*, approaching more the typical *Obolus*, the other, *Leptembolon*, being closer to *Lingula*.

The delimitation of the species presents similar difficulties to those in the allied genus *Lingula*. The differences are manifest, but are difficult to express in words. This is true especially of some species of the subgenera *Euobolus* and *Schmidtia*.

The introduction of the subgenus *Euobolus* for the radially striated Oboli does not appear to be necessary for a proper classification of the genus. If the radially striated species are considered to be the typical form of *Obolus*, then those differing from it to a sufficient degree may be referred to a subgenus. The genus *Lingulella* has only radially striated forms included within it, and this in part includes species that otherwise would be referred to *Euobolus*. To this extent *Euobolus* is a synonym of *Lingulella*.

I have endeavored to identify in material from the typical localities the varieties of *Obolus* and its subgenera described by Mickwitz, but find it practically impossible in nearly all cases. They may be found of value to the special student, but they are not of service in studies of the Cambrian fauna. Such minute discriminations would lead to an endless amount of detailed description if followed in the study of the faunas as they occur in the collections before me.

Fordinia Walcott [1908d, p. 64] includes specimens that have a *Lingulella*-like outline, with the development of a tendency to form a platform or thickening in the valves. Type: *Obolus* (*Fordinia*) *perfectus* Walcott.

Leptembolon Mickwitz [1896, p. 199] is referred to in this monograph as a subgenus of *Lingulella*.

Lingulepis Hall [1863, p. 129] is referred to in this monograph as a subgenus of *Lingulella*.

Lingulobolus Matthew [1895b, p. 260] is a *Lingulella*-like form, with a thick, strongly arched shell and surface marked by subimbricated wavy concentric lines. Type: *Lingulella? affinis* Billings (Pl. XVI, figs. 1, 1a–e).

Mickwitzella Walcott [1908d, p. 70] is an *Obolus* with strong, uniformly curved concentric striæ, with the lamellæ of growth fringed along their anterior (external) edges. Type: *Obolus siluricus* Eichwald (Pl. XV, figs. 1, 1a–c).

Monobolina Salter [1866b, p. 334] has been referred to as a subgenus of *Obolus* by Matthew [1902b, p. 98]. It differs from *Obolus* in having a platform in the ventral valve of the same type as that of *Elkania* (Pl. LI, figs. 1, 1a, and 4b) and is clearly not descendant from *Obolus* or generically connected with it. Salter [1866b, p. 334] placed *Monobolina* as a section of the genus *Obolella* Billings.

Palæobolus Matthew [1899, p. 201] shows concentric lines which are elevated and slightly irregular. The visceral area (splanchnocœle) is large and elongate, and the main vascular canals are close to the visceral area (Pl. XXXII, figs. 5, 5a–g). The surface of *Palæobolus* is of the same type as that of *Acritis*, but the visceral cavity and vascular canals differ materially in the two forms. Type: *Palæobolus bretonensis* Matthew.

Schmidtia Volborth [1869, p. 208] is a *Lingulella*-like shell without radial striation. All the species are small and as the concentric striation is very fine the shell surface is nearly smooth. Type: *Schmidtia celata* Volborth (Pl. XIV, figs. 1, 1a–c).

Westonia Walcott [1901, p. 691] is a *Lingulella*-like form distinguished by peculiar, transverse, semi-imbricating, "ripple-embossed" lines that cross both the concentric and radiating striæ. Type: *Lingula aurora* Hall (Pl. XLVI).

Stratigraphic range of Obolus and subgenera.—*Obolus* has a stratigraphic distribution ranging from the limits of the *Olenellus* fauna, through the Middle Cambrian or *Olenoides* fauna and the Upper Cambrian or *Dikellocephalus* [*Olenus*] fauna, into the base of the Ordovician fauna. *Obolus* proper has not been found below the upper portion of the Lower Cambrian. The youngest species of the genus are the largest, and also have certain strongly marked characteristics which

have grouped them under the subgenus *Lingulobolus*. The species referred to *Obolus* from the Lower Cambrian include *Obolus prindlei* (Pl. XXVII, figs. 3, 3a–e) which is intermediate in form between *Obolus apollinis* (Pl. XIV, figs. 6, 6a) and the type species of the genus *Lingulella*, *L. davisi* (Pl. XXXI, figs. 6e, 6f). *Obolus smithi* (p. 416) is a typical form of *Obolus*, while *Obolus parvus* (p. 408) is a minute form of which only the exterior is known.

Of the 77 species and 11 varieties from the Cambrian referred in this memoir to *Obolus* and its subgenera, 4 species occur in the Lower Cambrian, 46 species and 5 varieties in the Middle Cambrian, 43 species and 7 varieties in the Upper Cambrian, and 10 species in the passage beds between the Cambrian and Ordovician. From the Ordovician 23 species are described. (See table of species, pp. 110 and 113.)

Acritis is represented in the Upper Cambrian of Russia by the type species. A species is doubtfully referred to it from Nevada.

Bröggeria is represented by one species. This is found in the Upper Cambrian and the passage beds to the Ordovician of the North Atlantic province of Europe and eastern North America.

Fordinia includes species from the Middle and Upper Cambrian of Utah and Nevada.

Lingulobolus is represented by two species occurring in the Lower Ordovician rocks of Newfoundland and in conglomerate pebbles in Massachusetts.

Mickwitzella is confined to one species identified from the passage beds between the Upper Cambrian and the Ordovician of Russia.

Palæobolus is represented by a single species from the Middle Cambrian of Nova Scotia.

Schmidtia is represented in the Upper Cambrian "*Obolus*" sandstones of Russia by four species, which form a peculiar and restricted local group.

Westonia has its greatest development in the Middle Cambrian, where thirteen species and one variety occur. Six species are known from the Upper Cambrian, one from the passage beds to the Ordovician, and five in the lower portion of the Ordovician.

Geographic distribution of Obolus and subgenera.—In Europe *Obolus* proper appears to be limited to the type area in northwestern Russia, where it reaches its greatest development, and to a few limited localities in Bohemia and Sweden. Its subgenera, especially *Westonia*, have a wide distribution, the latter having been found in Russia, Bohemia, many localities on the Scandinavian Peninsula, England, and China.

Only one form is known from Sweden—*O. schmalenseei* (Walcott). The genus (or one of its subgenera) appears to be present in the Cambrian of Argentina, and four species have been described from eastern China—*O. chinensis* (Walcott), *O. minimus* Walcott, *O. obscurus* Walcott, and *O. shansiensis* Walcott. It is on the North American continent that *Obolus* reaches its greatest development outside of its original localities in Russia. It is widely distributed and often occurs in great numbers at favorable localities. It occurs along the lines of the Appalachian Range from Newfoundland, Cape Breton, and New Brunswick to Tennessee. It is represented in the northern Mississippi Valley region, in the isolated uplifts of Cambrian rocks in the Black Hills of South Dakota, the Ozark Mountains of Missouri, the Llano Hills of central Texas, and westward in Wyoming, Montana, Utah, and Nevada.

Of the species in this memoir that are placed under *Obolus* from Bohemia, *O. feistmanteli* (Barrande) and *O. complexus* Barrande are probably true representatives of the genus, but the following species are exceedingly doubtful in their generic identification:

Obolus ? advenus Barrande.
Obolus ? ancillus (Barrande).
Obolus ? bavaricus (Barrande).
Obolus ? minor Barrande.
Obolus ? mirandus (Barrande).
Obolus ? palliatus Barraude.
Obolus ? rokitzaneusis Barrande.

This is true also of the two forms from Sardinia: *Obolus? zoppi* Walcott, and *O.? meneghinii* Walcott.

The species of the genus and its subgenera recognized by Mickwitz [1896] in Russia are:

Obolus (Acritis) antiquissimus (Eichwald).
Obolus (Euobolus):
- apollinis Eichwald.
- apollinis iugricus (Eichwald).
- apollinis maximus Mickwitz.
- apollinis quenstedti (Mickwitz).
- eichwaldi Mickwitz.
- elegans Mickwitz.
- panderi Mickwitz.
- schmidti Mickwitz.
- triangularis Mickwitz.
- triangularis inornatus Mickwitz.
- volborthi Mickwitz.

Obolus (Leptembolon) lingulæformis Mickwitz.
Obolus (Mickwitzella) siluricus (Eichwald).
Obolus (Schmidtia):
- acuminatus Mickwitz.
- acuminatus alatus Mickwitz.
- acuminatus humeratus Mickwitz.
- acuminatus subtriangularis Mickwitz.
- celatus (Volborth).
- celatus orbiculatus Mickwitz.
- celatus præcisus Mickwitz.
- crassus Mickwitz.
- crassus angulatus Mickwitz.
- obtusus Mickwitz.
- obtusus acutus Mickwitz.
- obtusus ellipticus Mickwitz.
- obtusus extenuatus Mickwitz.
- obtusus latus Mickwitz.
- obtusus longus Mickwitz.
- obtusus minutus Mickwitz.

Obolus acadicus Walcott.

Plate XI, figure 5.

Obolus acadica Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 324–325. (Characterized and discussed as below as a new species.)

Only interiors of the dorsal valve of this species occur in the collections made by Loper on McNeil Brook in 1900. The material was provisionally referred to *Lingulella concinna* Matthew, but the broadly rounded subquadrilateral form of the dorsal valve seems to distinguish it from that species and also from *Obolus* (*Palæobolus*) *bretonensis* (Matthew).

The visceral area is narrow, extending a little in advance of the center of the valve. The main vascular trunks are narrow and widely separated. They belong to the submarginal group and are thus quite unlike those of *O.* (*P.*) *bretonensis*. The exterior surface and ventral valve are unknown.

The specific name is derived from Acadia, the original name for Nova Scotia, in which the species occurs.

Formation and locality.—**Upper Cambrian**: (3h) Shale and shaly limestone on McNeil Brook, 1.5 miles (2.4 km.) east of Marion Bridge, eastern Cape Breton, Nova Scotia.

Obolus? advenus Barrande.

Plate XII, figures 5, 5a–b.

Obolus? advena Barrande, 1879, Système silurien du centre de la Bohême, vol. 5, pt. 1, Pl. XCV, figs. IV: 1–2. (No text reference. Figs. 2A, 1A, and 2B are copied in this monograph, Pl. XII, figs. 5, 5a–b, respectively.)

This species is known to me only by the figures of Barrande [1879b, Pl. XCV, fig. IV] some of which are copied on Plate XII. The species is of the same type as *O. complexus* Barrande, so far as the means of comparison permit us to judge. It occurs at the same relative geologic horizon as *O. complexus*.

Formation and locality.—**Lower Ordovician**: (303d [Barrande, 1879b, Pl. XCV]) Étage d1, Swarow, Bohemia, Austria-Hungary.

Obolus anceps Walcott.

Plate X, figures 3, 3a–f.

Obolus anceps Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 388–389. (Described and discussed as below as a new species.)

General form broadly ovate, somewhat subcuneate. Valves moderately convex. Surface marked by fine lines of growth, and finer slightly undulating concentric striæ; when the outer layer is exfoliated the outer surface of the inner layer is marked by very fine, radiating striæ and numerous lines of growth; the inner surface of the shell is nearly smooth, judging from a

partial cast in the limestone. The shell is relatively thin and formed of a very thin outer layer and one or more thin inner layers or lamellæ, which thicken the shell from the umbonal region and toward the front and sides.

A cast of the interior of a dorsal valve that is referred to this species shows that a strong median ridge was present; also a median septum and a strong main vascular sinus. The area is short and marked by rather prominent flexure lines, as indicated by the flexures in the transverse lines of growth.

Observations.—This species might be taken for the young of *O. matinalis* (Hall) or *O. mæra* (Hall and Whitfield), were it not for the great difference in the thickness of the shell. It occurs at a slightly higher horizon at the base of the Pogonip limestone.

Formation and locality.—**Lower Ordovician (63)** *Limestone at the base of the Pogonip limestone northeast of Adams Hill, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.*

Upper Cambrian: (61) Limestone in the Dunderberg shale [Walcott, 1908f, p. 184], a little south of the Hamburg mine, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

Obolus? ancillus (Barrande).

Plate XII, figure 2.

Lingula ancilla Barrande, 1879, Système silurien du centre de la Bohême, vol. 5, pt. 1, Pl. CXI, fig. VI: 3. (No text reference. Fig. 3 is copied in this monograph, Pl. XII, fig. 2.)

This is a small shell of which we have only the one figure given by Barrande [1879b, Pl. CXI, fig. VI: 3] from which to express an opinion as to its generic relations. The configuration of the valve and the lamellose character of the shell, as indicated by the portions adhering to the cast, are what has led me to make the provisional reference to *Obolus*. There are no interior characters shown in the figure.

Formation and locality.—**Lower Ordovician:** (**303g** [Barrande, 1879b, Pl. CXI]) Étage d1, at Rabenberg, Bohemia, Austria-Hungary.

Obolus apollinis Eichwald.

Text figures 4 and 15, page 299; Plate VII, figures 1–8, 10–17; Plate XIV, figures 6, 6a.

Obolus apollinis Eichwald, 1829, Zoologia specialis, vol. 1, p. 274, Pl. IV, figs. 5a–b. (Described in Latin as a new species.)

Ungula plana Pander, 1830, Beiträge zur Geognosie des russischen Reiches, pp. 59 and 163, Pl. XXVIII, figs. 3a–b, 5a–b. (Characterized in German on p. 59; description of plate on p. 163.)

Ungula plana or *convexa* Pander, 1830, idem, p. 163, Pl. XXVIII, figs. 2a–b. (Only the description of the plate occurs on p. 163.)

Ungula rotunda Pander, 1830, idem, pp. 59 and 163, Pl. XXVIII, figs. 4a–b. (Characterized in German on p. 59; description of plate on p. 163.)

Ungula ovata Pander, 1830, idem, pp. 59 and 154, Pl. III, fig. 23 (not Pl. XXVIII, figs. 6a–b, referred to *Obolus* (*Schmidtia*) *celatus*). (Characterized in German on p. 59; description of plate on p. 154.)

Ungula transversa Pander (in part), 1830, idem, pp. 59 and 163, Pl. XXVIII, figs. 7a–b, 8a–b? (not Pl. III, fig. 24, which represents a specimen of *Obolus apollinis quenstedti*). (Characterized in German on p. 59; description of plate on p. 163.)

Ungula triangularis Pander, 1830, idem, pp. 59, 154, and 163, Pl. III, fig. 25, Pl. XXVIII, figs. 9a–b. (Characterized in German on p. 59; descriptions of plates on pp. 154 and 163.)

Obolus apollinis Eichwald, 1840, Jour. Natur- und Heilkunde Medizinischen Akad. St. Petersburg, pts. 1 and 2, p. 167. (Not seen.)

Orthis ungula von Buch, 1841, Archiv für Mineralogie, Bd. 15, Hft. 1, pp. 7–8, Pl. II, fig. 9. (Described and discussed in German, as belonging with the "*Unguliten.*")

Obolus apollinis Eichwald, 1843, Beiträge zur Kenntniss des russischen Reiches, Bd. 8, No. 2, p. 140. (Discussed in German.)

Obolus apollinis Eichwald, de Verneuil (in part), 1845, Géologie de la Russie d'Europe, by Murchison, de Verneuil, and de Keyserling, vol. 2, pt. 3, pp. 290–292, Pl. XIX, figs. 3a–d. (Described and discussed in French; see Matthew, 1892, pp. 43–44, for translation. De Verneuil includes *Obolus apollinis ingricus*, *Obolus* (*Acritis*) *antiquissimus*, and *Obolus* (*Mickwitzella*) *siluricus* in this species.)

Obolus apollinis Eichwald, Kutorga, 1848, Verhandl. Russ.-kais. min. Gesell. St. Petersburg for 1847, No. 12, pp. 251 and 252. (Discussed in German.)

Aulonotreta polita Kutorga (in part), 1848, idem, pp. 279–282, Pl. VII, figs. 10a–f. (Described and discussed in German as a new species. The text includes *Obolus apollinis*, *Obolus apollinis ingricus*, and *Obolus* (*Mickwitzella*) *siluricus*.)

Obolus apollinis Eichwald, Morris, 1849, Annals and Mag. Nat. Hist., 2d ser., vol. 4, p. 316. (Merely changes generic and specific reference of Kutorga's *Aulonotreta polita*.)

Obolus apollinis Eichwald, Davidson (in part), 1853, British Fossil Brachiopoda, vol. I, introduction, No. 3, figs. 51 and 52, p. 136, and Pl. IX, figs. 280–284 (not fig. 285, which represents *Obolus* (*Acritis*) *antiquissimus*). (No text reference. Figs. 280 and 281 appear to be drawn from the specimens figured by Kutorga, 1848, Pl. VII, figs. 10a and 10f, respectively; figs. 282, 283, and 284 are drawn from the specimens figured by Kutorga, 1848, Pl. VII, figs. 10b′, 10c, and 10e, respectively.)

Obolus apollinis Eichwald, 1860, Lethæa rossica, ancienne période, vol. 1, sec. 2, pp. 925–926. (Described and discussed in French.)

Obolus apollinis Eichwald, Schmidt, 1861, Archiv für Naturkunde Liv-, Ehst-, und Kurlands, 1st ser., Bd. 2, p. 218. (Localities mentioned in German.)

Obolus apollinis Eichwald, Billings, 1872, Canadian Naturalist, 2d ser., vol. 6, No. 2, p. 218, fig. 7, p. 217. (Discussed. Fig. 7 is copied from Davidson, 1853, Pl. IX, fig. 283.)

Obolus apollinis Eichwald, Billings, 1872, Am. Jour. Sci., 3d ser., vol. 3, p. 356, fig. 7, p. 355. (Copy of preceding reference.)

Obolus apollinis Eichwald, Roemer, 1876, Lethæa geognostica, pt. 1, Lethæa palæozoica, Atlas, Pl. II, figs. 7a–c. (No text reference. Figs. 7a–c are copied from de Verneuil, 1845, Pl. XIX, figs. 3b, 3a, and 3d, respectively.)

Obolus apollinis Eichwald, Zittel (in part), 1880, Handbuch der Palæontologie, Bd. I, Abth. I, p. 664, figs. 488a–c (not fig. 488d, which represents *Obolus apollinis quenstedti*). (No text reference. Figs. 488b and 488c are roughly copied from Davidson, 1853, Pl. IX, fig. 283, and fig. 52, p. 136, respectively. Fig. 488a appears to be roughly copied from Kutorga, 1848, Pl. VII, fig. 10a′.)

Obolus apollinis Eichwald, Noetling, 1883, Jahrb. König. preuss. geol. Landesanstalt Berlin for 1882, p. 265. (New locality mentioned in German.)

Obolus apollinis Eichwald, Roemer, 1885, Paleontologische Abhandlungen von Dames und Kayser, Bd. 2, Hft. 5, pp. 23–24 (270–271), Pl. I (XXIV), figs. 2a–d. (New localities mentioned in German. Figs. 2b, 2c, and 2d are copied from de Verneuil, 1845, Pl. XIX, figs. 3b, 3a, and 3d, respectively.)

Ungulites apollinis (Eichwald), Quenstedt, 1885, Handbuch der Petrefactenkunde, Aufl. 3, pp. 755 and 756; fig. 262, p. 755, and Pl. LVIII, figs. 56–57. (Characterized in German.)

Obolus apollinis Eichwald, Gagel, 1890, Beitr. zur Naturkunde Preussens, von Physikal.-oekonom. Gesell. Königsberg, 6, pp. 21–22, Pl. I, figs. 16, 16a–c. (Described in German. Figs. 16, 16a–c are very rough copies of the figures given by Roemer, 1885, Pl. I (XXIV), figs. 2a–d, respectively.)

Obolus apollinis Eichwald, Matthew, 1892, Trans. Roy. Soc. Canada for 1891, 1st ser., vol. 9, pp. 43–44. (A translation of the description given by de Verneuil, 1845, pp. 291–292.)

Obolus apollinis Eichwald, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, figs. 247 and 248, p. 242. (No text reference. Fig. 247 is copied from Davidson, 1853, Pl. IX, fig. 283; fig. 248 is copied from Kutorga, 1848, Pl. VII, fig. 10b′.)

Obolus apollinis Eichwald, Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, figs. 247 and 248, p. 558. (Copy of preceding reference.)

Obolus apollinis Eichwald, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, footnote, p. 80, and figs. 33–34, p. 80. (Figures representing species discussed. Fig. 33 is copied from Davidson, 1853, Pl. IX, fig. 283; fig. 34 is copied from Kutorga, 1848, Pl. VII, fig. 10b′.)

Obolus apollinis Eichwald, Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 133–137, Pl. I, figs. 1–14. (Described and discussed in German; see below for translation of the essential parts.)

Obolus apollinis Eichwald, Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, Pl. XXVI, figs. 3–6. (No text reference. The specimens represented by figs. 3–6 are redrawn in this monograph, Pl. VII, figs. 10–13, respectively.)

Obolus apollinis Eichwald, Moberg and Segerberg, 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), p. 65, Pl. III, figs. 1–3. (Specimens from new localities discussed in Swedish.)

Obolus apollinis Eichwald, Westergård, 1909, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 4 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 20), p. 56, Pl. II, figs. 14–16. (Localities mentioned in Swedish. Figs. 14–16 are copied from Moberg and Segerberg, 1906, Pl. III, figs. 1–3, respectively.)

Obolus apollinis being the type of the genus, I have reproduced the diagnosis by Mickwitz [1896, p. 133] with the accompanying remarks:

The series of forms comprised under *O. apollinis*, and connected with each other by many transitions, show such departures in their extreme forms that an abundant material was necessary in order to show that they belong together. With the increasing number of different forms there was an increasing difficulty in grouping them and in deciding the question as to which of these many forms were to be regarded as species and which as varieties. The small oval valves corresponding to Eichwald's original in the Zoologia specialis show the generic characters much less pronounced than many of the forms described below. Still Eichwald's conception was retained and merely somewhat amplified by the incorporation of a small rounded form, because this form showed closer relation to Eichwald's original than to the more divergent large forms described as varieties.

Diagnosis: Shells flat, outline oval to rounded, tip of beak of the large valve somewhat drawn forward and somewhat curved inward. Concentric and radial striation faint and irregular, the latter somewhat unpronounced, at times lost in an irregularly rent shell surface, but always recognizable at the posterior edges of the shell. Front and side edges thin, sharp, brittle, lying in the same plane as the thickened edges of the beak. Area in the median line somewhat concave; pedicle furrow distinctly developed, slightly tapering toward the apex of the beak. Lines of folding of the area lamellæ slightly concave to the median line of the valve and converging into the apex of the beak. The thickening of the posterior half of the valve is massive; the slope of the thickening down to the middle of the valve, in the large valve, shows longitudinal striæ and transverse traces of the secondary vessels. The traces of the main vessels in both valves are broad and flat and on both sides marked at the bottom by narrow grooves. The grooves of the secondary vessels, radiating into the interior of the valves, are rectilinear, unbranched, and at right angles to the grooves of the main vessels. The central pit has the shape of the conventional heart, opens into the brachiocœle through the median furrow and shows longitudinal striæ at its posterior edge. The muscular attachments of the combined outside lateral and central muscles of the large valve are drawn out into furrows toward the beak, which extend beyond the posterior edge of the central pit.

Observations: The defective condition of the shells leaves many characters uncertain. Thus even in relatively well-preserved specimens the edges of the shells are broken off and show neither the anterior course of the main vessels nor the mouths of the secondary vessels where they enter the peripheral vascular canal.

The scars of the anterior lateral muscles of the small valve, which, owing to their position far forward, are also for the most part broken off with the edge of the valve, were seen in three specimens.

In the typical form there seems to be a certain correlation between form, shell surface, and internal configuration, but this correlation is not carried out very rigorously. The oval forms have the tip of the beak drawn somewhat farther forward; the radial striation in them is for the most part less pronounced, while the concentric striation is stronger and more roughly engraved. At the same time the shell surface is duller and lacks the strong varnish-like gloss which is peculiar to the Oboli. To this external condition corresponds a less thickening of the posterior part of the shell, and as a consequence a less pronounced development of all the characters connected with the thickening, such as septa, ridges, central pit, etc. The internal marks of the last-named specimens are all developed to a recognizable degree, hut they lack relief.

Quite different is the case with the rounder forms. The shell surface is smoother and glossier, the concentric and radial striation more alike, though the latter is always fainter, and at times is overpowered by the beginnings of an irregular cracking of the surface, which is fully developed in *O. apollinis ingricus*. At the same time the internal configuration shows a plasticity often bordering on the monstrous.

* * * * * * *

To *O. apollinis* in the narrower sense belong most of the forms described by earlier authors, in particular *O. apollinis* Eichwald [1829, p. 274, Pl. IV, figs. 5a–b], *Ungula ovata* Pander [1830, p. 59, Pl. III, fig. 23] (while the valve figured by the same author in figs. 6a–b, Pl. XXVIII, belongs to a *Schmidtia*), *O. ingricus* von Leuchtenberg [1843, p. 16, Pl. II, figs. 7–8], *O. apollinis* de Verneuil [1845, p. 290, Pl. XIX, fig. 3c], *Aulonotreta polita* Kutorga [1848, p. 278, Pl. VII, figs. 10a, a′, c?, d?, e?]; the other forms of Kutorga, so far as they may be recognized, belong to the varieties of Eichwald's species.

The specific name is derived from Apollo, the name *Obolus apollinis* signifying "a coin of Apollo."

Formation and locality.[a]—**Upper Cambrian:** (**395f**) *Obolus* conglomerate throughout the east Baltic region; (**336c**) *Obolus* sandstone at Reval; (**395**) *Obolus* sandstone at Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval; (**395b**) *Obolus* sandstone at Ilgast; (**9d**) *Obolus* sandstone at Jaggowal, about 20 miles (32.2 km.) east-southeast of Reval; (**336b**) *Obolus* sandstone on Odensholm Island, about 55 miles (88.6 km.) west of Reval; (**336m**) *Obolus* sandstone at Baltischport, about 30 miles (48 km.) west of Reval; (**336t**) *Obolus* sandstone at Wiems, 5 miles (8 km.) north-northeast of Reval; and (**336s**) *Obolus* sandstone at Narwa; all in the Government of Esthonia, Russia.

(**395z**) *Obolus sandstone at Jamburg on Louga (Luga) River;* (**336a**) *Obolus* sandstone at Podolova (Putalova?) on Ijora (Ischora) River; (**336u**) *Obolus* sandstone on the bank of Louga (Luga) River, southwest of St. Petersburg; (**336k**) *Obolus* sandstone on Volkhof (Wolchow) River; (**336l**) *Obolus* sandstone on the bank of Sjass (Sias) River, near Lake Ladoga; all in the Government of St. Petersburg, Russia.

(**336r**) *Obolus* sandstone in the entire region between Volkhof (Wolchow) and Sjass (Sias) rivers on the east and Baltischport on the west, Governments of Novgorod, St. Petersburg, and Esthonia, Russia.

(**311w**) Drift bowlder of *Obolus* sandstone [Wiman, 1902, p. 68], Mariehamn, Åland Island, Finland, Russia.

(**386c**) Drift bowlder found near Lyck, East Prussia; and (**386d**) drift bowlder found near Danzig, West Prussia; both in Germany.

(**321**, **321a–d**, and **321o**) Drift bowlders of *Obolus* sandstone, Nos. 1–23, and 25–29 [Wiman, 1902, p. 68], on Fanton Island, parish of Börstil, Province of Stockholm; (**390l**) *Obolus* conglomerate at Klittberget, in Dalarne, Province of Kopparberg; (**9e**) Sandstone in the *Obolus* conglomerate at Boda, north of Rattvik, Dalarne; (**311v** [Wiman, 1902,

[a] The collections of the United States National Museum contain specimens of *Obolus apollinis* from Localities **9d**, **9e**, **336s**, **395**, **395b**, and **895z**. The other localities mentioned are taken from the references given in the synonymy. The authority for each locality cited will he found in the list of localities, pp. 161–291.

p. 68]) Drift bowlder of *Obolus* sandstone, Erskolmen Island, parish of Börstil, southeast of Öregrund, Province of Stockholm; and (**390m**) conglomerate overlying the "glauconite sand" at Horn, Oeland Island; all in Sweden.

Middle Cambrian: (**368**) Quartzitic sandstone in the Pepper Mountains, near Sandomierz, on the Vistula, Russian Poland.

Obolus apollinis ingricus (Eichwald).

Obolus ingricus Eichwald, 1829, Zoologia specialis, vol. 1, p. 274. (Described in Latin as a new species.)

Obolus ingricus Eichwald, 1843, Beiträge zur Keuntniss des russischen Reiches, Bd. 8, No. 2, pp. 140–141. (Characterized and discussed in German.)

Obolus apollinis Eichwald, de Verneuil (in part), 1845, Géologie de la Russie d'Europe, by Murchison, de Verneuil, and de Keyserling, vol. 2, pt. 3, pp. 290–292 (not Pl. XIX, figs. 3a–d, which represent specimens of *Obolus apollinis*). (Described and discussed in French. The reference includes *Obolus* (*Acritis*) *antiquissimus*, *Obolus* (*Mickwitzella*) *siluricus*, *Obolus apollinis*, and *Obolus apollinis ingricus*, *Obolus apollinis* being figured.)

Obolus ingricus Eichwald, von Leuchtenberg, 1843, Beschreibung einiger neuen Thierreste der Urwelt von Zarskoe-Selo, p. 16, Pl. II, figs. 7 and 8. (Not seen.)

Aulonotreta polita Kutorga (in part), 1848, Verhandl. Russ.-kais. min. Gesell. St. Petersburg for 1847, pp. 279–282 (not Pl. VII, figs. 10a–f, which represent specimens of *Obolus apollinis*.) (Described and discussed in German as a new species. The text includes *Obolus apollinis ingricus*, *Obolus* (*Mickwitzella*) *siluricus*, and *Obolus apollinis*, the last species being figured.)

Obolus ingricus Eichwald, 1860, Lethæa rossica, ancienne période, vol. 1, sec. 2, pp. 926–927. (Described and discussed in French.)

Obolus apollinis ingricus (Eichwald), Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 137–140, Pl. I, figs. 15–28. (Described and discussed in German.)

Mickwitz states that this shell has the same form as *O. apollinis* but that it is much larger and the surface is more frequently and strongly marked by the concentric striæ and lines of growth; the central pit of the ventral valve is more pear-shaped. A full description is given of the details of exterior form and interior markings of the valves so far as known to him.

Formation and locality.[a]—**Upper Cambrian:** (**336a**) *Obolus* sandstone at Podolova (Putalova?) on Ijora (Ischora) River; and (**395z**) *Obolus sandstone at Jamburg on Louga* (*Luga*) *River;* both in the Government of St. Petersburg, Russia.

(**395**) *Obolus* sandstone at Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval; (**395a**) *Obolus* sandstone at Tihala, near Jegelecht, 12 miles (19.3 km.) east of Reval; (**336c**) *Obolus* sandstone at Reval; (**336t**) *Obolus* sandstone at Wiems, 5 miles (8 km.) north-northeast of Reval; and (**336s**) *Obolus* sandstone at Narwa; all in the Government of Esthonia, Russia.

Obolus apollinis maximus Mickwitz.

Plate VII, figure 9; Plate XIV, figures 7, 7a.

Obolus apollinis maximus Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 140–143, Pl. I, figs. 29–38. (Described and discussed in German as a new variety.)

Mickwitz states that this shell is very large, 21 mm. or more in diameter. It has more regular, radial, and concentric striations than the variety *ingricus* and the surface is smoother. The ventral valve near the beak is very thick. An elaborate description is given, accompanied by full illustration.

Formation and locality.—**Upper Cambrian:** (**395**) *Obolus sandstone at Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval;* and (**395f** [Mickwitz, 1896, p. 142]) *Obolus* conglomerate throughout the east Baltic region; both in the Government of Esthonia, Russia.

(**336j**) *Obolus* sandstone at Staroja Ladoga, Government of Novgorod, Russia.

Obolus apollinis quenstedti (Mickwitz).

Text figures 34A–B, page 374.

Ungula convexa Pander, 1830, Beiträge zur Geognosie des russischen Reiches, pp. 59 and 163, Pl. XXVIII, figs. 1a–b. (Characterized in German on p. 59; description of plate on p. 163.)

Ungula transversa Pander (in part), 1830, idem, pp. 59 and 154, Pl. III, fig. 24 (not Pl. XXVIII, figs. 7a–b and (?) 8a–b, which represent specimens of *Obolus apollinis*). (Characterized in German on p. 59; description of plate on p. 154.)

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[a] All of the localities mentioned are taken from the references given in the synonymy. The authority for each locality cited will be found in the list of localities, pp. 161–291.

Ungulites sp. QUENSTEDT, 1837, Archiv für Naturgeschichte, von A. F. A. Wiegmann, Jahrg. 3, Bd. 1, pp. 143–145, Pl. III, figs. 7 and 8. (Described and discussed in German.)

Obolus apollinis ZITTEL (in part) [not EICHWALD], 1880, Handbuch der Palæontologie, Bd. 1, Abth. 1, p. 664, fig. 488d (not figs. 488a–c, which represent *Obolus apollinis*). (No text reference. Fig. 488d is roughly copied from Quenstedt, 1837, Pl. III, fig. 7.)

Obolus quenstedti MICKWITZ, 1892, Mélanges géol. et paléontol. tirés du Bull. Acad. imp. sci. St.-Pétersbourg, vol. 1, p. 62, fig. 1, and footnote on p. 60. (The description of the species is incorporated with that of the genus, which is in German. The two specimens represented by fig. 1 were redrawn by Mickwitz, 1896, figs. 6A–B, pp. 79 and 117, and then copied in this monograph, figs. 34A and 34B, p. 374.)

Obolus quenstedti Mickwitz, HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 243, figs. 244 and 245. (Generic reference questioned. Figs. 244 and 245 are copied from Mickwitz, 1892, fig. 1, p. 62.)

Obolus quenstedti Mickwitz, HALL and CLARKE, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, p. 559, figs. 244 and 245. (Text and figures copied from preceding reference.)

Obolus quenstedti Mickwitz, HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 339, figs. 38 and 39. (Discusses species, questioning its reference to *Obolus*. Figs. 38 and 39 are copied from Mickwitz, 1892, fig. 1, p. 62.)

Obolus apollinis quenstedti MICKWITZ, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 143–145, figs. 6A–B, p. 79, figs. 6A–B, p. 117, Pl. II, figs. 1–6. (Described and discussed in German; see below for translation of portions of the description. The text figures on p. 117, which are copied from those on p. 79, are copied in this monograph, figs. 34A and 34B, p. 374. Mickwitz's figures, pp. 79 and 117, are drawn from the specimens which he illustrated, 1892, fig. 1, p. 62, and which were copied by Hall and Clarke, 1892a, figs. 244 and 245, p. 243; 1892b, figs. 244 and 245, p. 559; and 1892c, figs. 38 and 39, p. 339.)

Obolus quenstedti Mickwitz, WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 385. (Translates part of the third paragraph on p. 25 of Mickwitz's paper, 1896, as below, and discusses the type species.)

Obolus quenstedti Mickwitz, MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 120. (Compared, as the representative of *Obolus*, with "*Lingulella selwyni*," as the representative of *Lingulella*.)

Of this shell Mickwitz [1896, p. 25] says:

A more accurate study of the greatly increased material has convinced me that *O. quenstedti* can not be maintained as a species, since it is merely the terminal link of a series of variations, which, like var. *maximus* and *ingricus*, can be traced back to *O. apollinis*. Thus the typical species remains *O. apollinis* Eichwald.

In describing *O. apollinis quenstedti* Mickwitz [1896, p. 143] says:

This variety is distinguished externally from the forms thus far described of *O. apollinis* by the circular outline of its valves, their less pronounced arching (in the mean 0.159 for the large valve, and 0.183 for the small valve), and by its smoother and more shining external shell surface, while by its size it is allied to the varieties *ingricus* and *maximus* (in the mean 21.5 mm.). The radial striæ are more strongly developed and more uniformly distributed over the shell surface than in other forms of Eichwald's species, and they often exceed the concentric striæ in distinctness.

The shells show two extreme forms connected by intermediate links. Those forms also show a corresponding variation in the development of the internal characters. * * *

The internal shell surfaces of this variety (*quenstedti*) are most vigorously chiseled of all the forms of *O. apollinis*, and although in all the details of their internal configuration they show merely the typical form, yet by the peculiar development of the characters they present a picture differing from the other forms of Eichwald's species. The peculiarity in the development of the internal characters of this variety consists in this, that both the elevations and the depressions are strongly developed, and in this way double the relief of the pattern. At the same time details become apparent which in the other forms are distinguishable only by reflected light. Such is the longitudinal striation of the posterior edge of the central pit.

The varietal name was given in honor of F. A. von Quenstedt.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**395** [*Mickwitz, 1896, p. 145*]) *Obolus sandstone at Joa;* and (**395a** [Mickwitz, 1896, p. 144]) *Obolus* sandstone at Tihala; both near Jegelecht, 12 miles (19.3 km.) east of Reval, Government of Esthonia, Russia.

(**395z** [Mickwitz, 1896, p. 144]) *Obolus* sandstone at Jamburg, on Longa (Luga) River, Government of St. Petersburg, Russia.

OBOLUS? BAVARICUS (Barrande).

Plate XV, figures 10, 10a.

Lingula bavarica BARRANDE, 1868, Faune silurienne des environs de Hof, en Bavière, p. 100, fig. 62. (Described and discussed in French as a new species. Fig. 62 is copied in this monograph, Pl. XV, fig. 10.)

Obolus? palliatus BARRANDE (in part), 1868, idem, pp. 104–105, fig. 64 (not fig. 65, which represents the species *palliatus*). (Described and discussed in French as a new species. Fig. 64 is copied in this monograph, Pl. XV, fig. 10a.)

Lingula bavarica BARRANDE, 1868, Neues Jahrb. für Mineralogie for 1868, pp. 690–691, unnumbered plate, fig. 62. (Text and figure copied from Barrande, 1868a, p. 100, fig. 62.)

Obolus? palliatus BARRANDE (in part), 1868, idem, p. 693, unnumbered plate, fig. 64 (not fig. 65, which represents the species *palliatus*). (Text and figure copied from Barrande, 1868a, pp. 104–105, fig. 64.)

The author states [1868a, p. 100] that this shell can only be described by its external appearance, and that this does not enable him definitely to identify it with *Lingula* or one of the more recently distinguished genera *Lingulella* or *Obolella*. The shell is compressed. The only portion preserved near the beak is about 0.5 mm. thick. Its external surface is marked by somewhat irregularly spaced concentric striæ, which are reproduced on the internal cast. Traces of longitudinal striæ are shown on the fragment of shell preserved. The shell has a length of 17 mm. and its greatest width is 16 mm. Comparison is made with *Obolella plumbea* Salter, of the English rocks, and attention is called to the fact that the English species belongs to the group of the lower Llandeilo, constituting a transition between the primordial and second faunas like the schists of Hof.

FORMATION AND LOCALITY.—**Passage beds** between the Upper Cambrian and Ordovician: (**303c** [Barrande, 1868a, p. 100]) suburbs of Hof, Bavaria, Germany.

OBOLUS BELLI (Billings).

Plate XXXVIII, figures 3, 3a–b.

Lingula belli BILLINGS, 1859, Canadian Naturalist, 1st ser., vol. 4, pp. 431–432, figs. 7 and 8. (Described and discussed as a new species, as below. The specimens figured by Billings are redrawn in this monograph, Pl. XXXVIII, figs. 3 and 3a, but it is impossible further to identify Billings's figures with those in this monograph.)

Lingula belli BILLINGS, 1863, Geol. Survey Canada, Fifteenth Rept. Progress, figs. 47a–b, p. 124. (No text reference. Figs. 47a–b are copied from figs. 7 and 8, respectively, of the preceding reference.)

The original description by Billings follows:

Oval, apical angle about 75°, lateral margins somewhat straight or gently convex for two-thirds of the length, front angles and anterior margins broadly rounded; length one-fourth or one-third greater than the width; greatest width at about one-third the length or a little less from the front. Large specimens are one inch long and nine lines wide, but the usual size is one-third smaller.

The form so far as regards convexity of the valves is somewhat variable. In general the specimens are strongly convex, or very obtusely carinate from the beak to near the center of the shell, and have three flat slopes, one to each of the lateral margins and one to the front. The most prominent point is a little above the middle, and the anterior slope is always larger than the others. From this form, which is that of a very low three-sided pyramid, with all the angles and edges broadly rounded, there is a series becoming more and more convex, until all trace of the anterior slope is lost, while the two lateral slopes are only visible for a short distance below the beaks. By taking the extremes several species might be made out of this one, but I am satisfied that they would not in the end be sustained.

The surface is sometimes nearly smooth, but usually it is marked by concentric undulations of growth. I have not been able to detect any minute concentric striæ between the larger undulations, and on only one of all the specimens that I have seen are there any longitudinal striæ, and these are only faintly indicated on the cast of the interior. The specimens collected in the Chazy limestone in the neighborhood of Montreal are of a jet-black color and often exhibit a polished shining surface, but those in the same rock in the valley of the Ottawa above Carillon are light brown.

The species is closely allied to *L. antiqua* (Hall) but is not longitudinally striated. In the Potsdam sandstone on lots 21 and 22, in the 9th concession of the Township of Bastard, *L. antiqua* occurs in vast abundance, and among the specimens collected at that locality there are a great many which have almost exactly the same form as *L. belli*, the only difference being the longitudinal striæ.

I have also before me specimens from the Falls of St. Croix in Wisconsin, said to be *L. prima* of the Potsdam, and these also have the depressed pyramidal elevation, but are in outline suborbicular or obscurely subpentagonal. The elongated form sometimes referred to *L. antiqua* appears to me to be *L. acuminata* (Conrad), and differs from all the above by being convex from the beak all along the median line to the front.

Billings [1859, p. 432] has indicated the resemblance of this species to "*L. antiqua* Hall" = *Lingulella* (*Lingulepis*) *acuminata* (Conrad). In addition, I find traces of the heart-shaped cavity of the ventral valve (Pl. XXXVIII, fig. 3a) so characteristic of *Obolus* and its subgenera. So far as known to me this is the latest species of *Obolus* known to occur in any American geologic section.

The specific name was given in honor of Rev. A. Bell, of L'Original, near Montreal, Canada.

FORMATION AND LOCALITY.—**Ordovician**: Chazy formation at the following localities [Billings, 1859, p. 432]: (**319n**) *Island of Montreal;* (**319o**) near L'Original; and (**319p**) on Allumette Island; all in the St. Lawrence River valley, Canada.

(**392h** [Billings, 1859, p. 432]) Limestone of the Chazy formation in the valley of Ottawa River, above Carillon, Quebec, Canada.

Obolus chinensis (Walcott).

Plate XXXIX, figures 7, 7a–b.

Obolus (*Lingulella*) *chinensis* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 328–329. (Described and discussed as below as a new species.)

General form broadly subovate, with the ventral valve broadly subacuminate and the dorsal valve oval, with the posterolateral slopes somewhat straightened. There is some variation in the proportions of width and length in different shells. Valves rather strongly convex for so thin a shell, in this respect resembling species of *Dicellomus*. Surface marked by fine concentric striæ and lines of growth and very fine undulating concentric lines; this outer surface is usually a dull black and adheres to the matrix; when the outer layer is exfoliated the surface is shiny black and marked by numerous radiating striæ in addition to concentric striæ; the inner surface shows a few scattered punctæ in addition to radiating and concentric striæ outside the visceral area. The shell is of medium thickness and formed of a thin outer layer and several inner layers or lamellæ that are slightly oblique to the outer layer; the lamellæ are more numerous and more oblique to the outer layer over the anterior and anterolateral portions of the shell. The ventral valves average 3 mm. in length, with width varying from 2 mm. to 2.5 mm. The dorsal valve is slightly shorter than the ventral when the two valves have the same width.

The interior of the ventral valve shows that the area is short and divided midway by a narrow pedicle furrow that merges into the visceral area which extends forward about one-third the length of the valve; on each side of the anterior central portion of the visceral area there are two small trapezoidal areas within which the central scars and the middle and outside lateral muscle scars were attached; the small transmedian and anterolateral muscle scars are situated close to the main vascular sinus opposite the anterior portion of the central visceral area. A partial cast of the interior of the dorsal valve shows a rather wide visceral area with the anterolateral scars about the center of the valve and the central scars about one-fourth of the distance back from the center to the posterior margin. Of the impressions left by the vascular system only the main vascular sinuses of the ventral valve have been seen. These are situated about midway between the central visceral area and the margins of the valve.

Observations.—This species occurs abundantly in association with *Acrotreta shantungensis* Walcott. It is closely related in form to *Obolus prindlei* (Walcott) of the upper *Olenellus* zone of eastern New York, and belongs with a group of small shells that have a wide vertical and geographic range, as is noted under the description of *O. prindlei*. With the data available for comparison it differs from *O. prindlei* in its shorter cardinal area, and visceral area in the dorsal valve. From *Lingulella damesi* (Walcott) it differs in being broader in proportion to its length.

Formation and locality.—**Middle Cambrian:** (**C62**) Earthy layer in the middle limestone of the Kiulung group [Blackwelder, 1907a, pp. 37 and 40 (last list of fossils) and fig. 10 (base of bed 7), p. 38], 2.5 miles (4 km.) south of Yenchuang, on the north-northeast spur of Hulushan, Sintai district, Shantung, China.

Obolus complexus Barrande.

Plate XII, figures 3, 3a, 8, 8a.

Obolus? complexus Barrande, 1879, Système silurien du centre de la Bohême, vol. 5, pt. 1, Pl. XCV, figs. III: 1–2; Pl. CXI, figs. VI: 1–2; Pl. CXIII, fig. V; and Pl. CLII, fig. II: 4. (No text reference. Pl. XII, figs. 3, 3a, 8, and 8a, of this monograph are copied from Pl. CLII, fig. II:4A; Pl. CXIII, fig. V:A; Pl. XCV, figs. III: 1A–B; and Pl. XCV, fig. III:2C, respectively.)

Obolella?? complexus Barrande, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 73, fig. 31. (Merely suggests change in generic reference. Fig. 31 is copied from Barrande, 1879b, Pl. CLII, fig. II:4A.)

Schmidtia?? complexus Barrande, Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 19–20. (Generic relations discussed in German.)

Barrande [1879b] recognized the relations of this species to *Obolus*, although at the time he did not have the results of Mickwitz's studies to aid him. The latter [1896, p. 19] considers

that Barrande's figure [1879, Pl. CLII, fig. II: 4] shows in the arrangement of the internal characters a remarkable similarity to the large valve of *Schmidtia*. (This figure is represented in Pl. XII, fig. 3, of this memoir.) A comparison with *O. feistmanteli* (Barrande) (Pl. XII, fig. 1d) shows the relation of the interior markings in the two species. However, the figure of *O. complexus*, which is an internal cast, has a pointed projection that indicates the presence of the transmedian and anterior lateral muscle scars much closer to the margin of the shell than the other species of the genus. I think, however, that we are justified in referring the species provisionally to *Obolus*. The specimens figured by Barrande [1879b, Pl. XCV, figs. II: 1–2] do not appear to me to represent this species. The valve from Kruschna Hora (Pl. XII, fig. 3a) probably represents a dorsal valve. All the characters known to me are shown by the figures. Hall and Clarke [1892c, p. 73] considered that the species might be a genuine *Obolella*.

FORMATION AND LOCALITY.—**Lower Ordovician**: (**303i**) *Étage d1, Kruschna Hora;* (**303h**) Étage d1, at Milinsky Wrch, near Woleschna; and (**303g**) Étage d1, at Rabenberg; all [Barrande, 1879b, Pls. XCV and CXI] in Bohemia, Austria-Hungary.

OBOLUS CYANE (Billings).

Plate XXVII, figures 4, 4a–b.

Lingula cyane BILLINGS, 1865, Geol. Survey Canada, Paleozoic Fossils, vol. 1, p. 216, figs. 200a–d, p. 215. (Described. Billings's type specimens are redrawn in this monograph, Pl. XXVII, figs. 4, 4a–b, but it is impossible further to identify his figures with those in this monograph.)

Glossina cyane (Billings), SCHUCHERT, 1897, Bull. U. S. Geol. Survey No. 87, p. 224. (Merely changes generic reference.)

General form ovate cuneate, broadly rounded at the front and sides, with the ventral valve subacuminate and the dorsal valve broadly rounded at the beak; valves rather strongly convex, especially the dorsal. Surface marked by concentric striæ and slight undulations of growth and by very fine radiating striæ; when the outer surface is exfoliated the inner layers or lamellæ are marked by numerous radiating striæ and concentric lines and undulations of growth; the casts of the interior show essentially the same markings as the inner layers, except over the visceral area, which is largely covered with fine papillæ corresponding to the minutely pitted surface of the shell's interior. The shell is thick and built up of a thin outer layer and numerous inner layers or lamellæ arranged over the anterior portions of the shell obliquely to the outer surface. Three ventral valves have an average length of 7 mm., with a width of 6 mm.; a dorsal valve 6 mm. in length is the same in width. The area of the ventral valve, as shown in a cast, is divided at the center by a strong pedicle furrow and about halfway between the pedicle furrow and the lateral margin by a sharp flexure line. The striæ of growth cross the area parallel with its base and show very clearly on the cast of the pedicle furrow. The area forms a thin shelf between the pedicle groove and the lateral margins, the undercut extending well back under the area. The area of the dorsal valve is relatively short and narrow, scarcely showing when viewed from above.

The cast of the visceral cavity is strongly marked, but in none of the specimens are the muscle scars shown. The central groove is shown in the cast by a rounded ridge, and the path of advance of the trapezoidal area (c), in which the central, middle, and outside lateral muscle scars occur, is beautifully shown by Plate XXXII, figure 4, the transverse ridges representing the lines of growth. The main vascular sinuses are fairly well shown in the same figure. There are no traces of a median septum in the ventral valve, but this structure is clearly shown in the casts of the dorsal valve, extending forward between the anterior lateral muscle scars.

The cast of the interior of the dorsal valve shows that in the adult the shell was thickened over the visceral area and that the muscle scars were located on a comparatively elevated platform. The position and form of the anterior lateral and central muscle scars and the direction of the scar of the parietal band are fairly well shown by Plate XXVII, figure 4b, as is also the umbonal scar (g).

Observations.—This is a most interesting species on account of its preserving well into Ordovician time the characteristics of well-marked forms of *Lingulella* from the Middle and Upper

Cambrian. This may be seen by comparing with figures of *Lingulella hayesi* (Walcott) (Pl. XXV) of the Middle Cambrian and *Lingulella radula* Matthew (Pl. XLV) of the Upper Cambrian.

Obolus cyane is of the same type as *Lingulella iole* (Billings) and is associated with it in a horizon that appears to correspond with the upper portion of the Chazy and base of the Trenton of the New York section. It differs in being more cuneate and less elongate.

FORMATION AND LOCALITY.—**Lower Ordovician:** (**314d**) Limestone of Division P [Billings, 1865a, p. 216] of the "Quebec group," 4 miles (6.4 km.) northeast of Portland Creek, Newfoundland.

OBOLUS DISCOIDEUS (Hall and Whitfield).

Plate XVIII, figures 6, 6a–d.

Obolella discoida HALL and WHITFIELD, 1877, U. S. Geol. Expl. 40th Par., vol. 4, p. 205, Pl. I, figs. 1 and 2. (Described. One of Hall and Whitfield's specimens, likely the one represented by fig. 2, is redrawn in this monograph, Pl. XVIII, fig. 6c; the specimen represented by fig. 1 is not figured in this monograph.)

Obolella discoidea Hall and Whitfield, WALCOTT, 1884, Mon. U. S. Geol. Survey, vol. 8, p. 14. (New localities mentioned.)

Obolella ? discoidea Hall and Whitfield, WALCOTT, 1886, Bull. U. S. Geol. Survey No. 30, p. 111. (Questions generic reference.)

Obolella ? discoidea Hall and Whitfield, HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 69. (Questions generic reference.)

Obolus (*Lingulella*) *discoideus* (Hall and Whitfield), WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 673. (Merely changes generic reference.)

General form broad ovate to subcircular, with the ventral valve obtusely acuminate and the dorsal valve more broadly rounded posteriorly; both valves depressed convex, the umbo of the ventral valve rising slightly toward the posterior margin. Surface of shell marked by very fine, concentric undulating striæ and lines of growth. When partly exfoliated the inner lamellose layers are imbricated, their outer edges being irregular. The only traces of the interiors observed show fine concentric striæ of growth. Shell of medium thickness. It is built up of a very thin outer layer and numerous inner layers arranged more or less obliquely to the outer layer over the frontal portions. The largest valve has a length of 4.25 mm. with a width of 4 mm. No interiors of either valve have been found among a large number of specimens.

Observations.—This pretty little shell is certainly not an *Obolella*. In shell structure and form it is like *Obolus*.

FORMATION AND LOCALITY.—**Lower Ordovician:** (**185z**) Limestones at the base of the Lower Ordovician [Walcott, 1908f, p. 191], in Blacksmith Fork Canyon, about 9 miles (14.4 km.) east of Hyrum, Cache County, Utah.

Upper Cambrian: (**313j** [*Hall and Whitfield, 1877, p. 205*]) *Limestone in the Eureka district;* (**66**) Dunderberg shale [Walcott, 1908f, p. 184], on the first ridge north of the Dunderberg mine; (**62**) limestone in the Dunderberg shale [see Walcott, 1908f, p. 184], in canyon immediately north of Adams Hill; and (**64**) limestone near the Bullwhacker mine; all in the Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

(**8f**) Limestones at summit of canyon, 10 miles (16.1 km.) south of Egan Canyon, east side of Egan Range, White Pine County, Nevada.

(**54e**) About 200 feet (61 m.) above the Middle Cambrian and 1,025 feet (212.4 m.) below the top of the Upper Cambrian, in limestones forming 3 of the St. Charles formation; and (**54f**) about 150 feet (45.7 m.) above the Middle Cambrian and 1,075 feet (327.7 m.) below the top of the Upper Cambrian in the light-gray sandstone forming 4 of the St. Charles formation; both in Blacksmith Fork Canyon [Walcott, 1908f, p. 193], about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

(**56g**) Limestone of the St. Charles formation [Walcott, 1908a, p. 6], in the valley of the stream which flows into Mill Canyon from the west, about 6 miles (9.6 km.) west-southwest of Liberty, and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho.

(**151**) Limestone in point overlooking Churn Canyon, on the west side of the Bridger Range, Gallatin County, Montana.

Middle Cambrian: (**58**) Shaly limestone in upper beds of Secret Canyon shale, east side of New York and Secret canyons, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

Specimens that are somewhat doubtfully referred to this species occur at the following locality:

Upper Cambrian: (**302r**) About 1,000 feet (305 m.) above the quartzitic sandstones in the "Yogo limestone (Devono-Silurian)" of W. H. Emmons [1907, p. 34], near Princeton, Philipsburg quadrangle (U. S. Geol. Survey), Granite County, Montana.

Obolus dolatus (Sardeson).

Text figures 35A–C.

Lingula dolata Sardeson, 1896, Bull. Minnesota Acad. Nat. Sci., vol. 4, p. 95, Pl. VI, fig. 12. (Described as a new species.)

Only the exterior of the valves of this species is known. The outline of the valves is much like that of *Obolus matinalis* (Hall) (Pl. VIII), and it does not differ more in this respect from

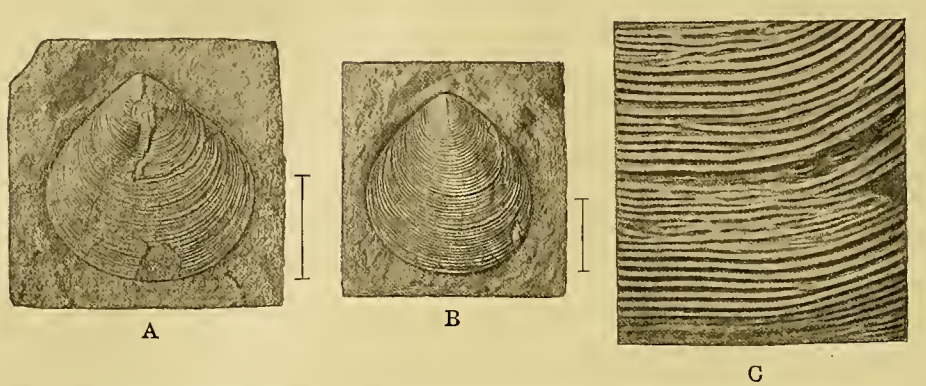


Figure 35.—*Obolus dolatus* (Sardeson). A, Exterior of a large, crushed ventral valve, the type specimen. B, Exterior of an elongate dorsal valve. C, Surface ridges on the front part of another dorsal valve, ×14.

The specimens represented are all from Locality **339**, near Stillwater, Minnesota, in beds which are reported by Sardeson to be the Lower Ordovician Oneota dolomite.

that species than specimens of *O. matinalis* differ from each other. The chief specific distinction is in the fine, narrow, sharp, slightly undulating, slightly inosculating concentric ridges; the spaces between the ridges are about twice the width of the ridges. This surface is somewhat similar to that on the interspaces between the beaded ridge of *Obolus* (*Mickwitzella*) *siluricus* (Pl. XV, fig. 1c).

It may be that when specimens of the interior of the valves are found other differences from *O. matinalis* will be noted. *Obolus dolatus* appears to be a Lower Ordovician representative of the widely distributed *O. matinalis*.

Formation and locality.—**Lower Ordovician:** (**339** [Sardeson, 1896, pp. 95 and 96]) from beds referred by Sardeson to the Oneota dolomite, Stillwater, Washington County, Minnesota.

Obolus eichwaldi Mickwitz.

Obolus eichwaldi Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 154–155, Pl. II, figs. 15a–d. (Described and discussed in German as a new species.)

Of this species Mickwitz had only the posterior portion of a dorsal valve and some small fragments. He states that the essential characteristics which distinguish it from *O. triangularis* Mickwitz are the much finer, more regular, concentric striation and the somewhat irregular, undulating, radial ribs, which give the surface a somewhat wavy appearance through their varying strength and occasional interruption. Mickwitz speaks of the circular form of the shell, but the lines of growth on the fragment illustrated (Pl. II, fig. 15a) indicate a somewhat transverse shell. He also mentions peculiarities in the area of the dorsal valve. The student is referred to the elaborate description of Mickwitz for further details.

Mickwitz states that *O. eichwaldi* is one of the rarest species of the *Obolus* sandstone.

The specific name was given in honor of C. E. von Eichwald.

Formation and locality.—**Upper Cambrian:** (**395** [Mickwitz, 1896, p. 155]) *Obolus* sandstone at Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval, Government of Esthonia, Russia.

Obolus elegans Mickwitz.

Plate XV, figure 3.

Obolus elegans Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 157–158, Pl. II, fig. 18. (Described and discussed in German as a new species.)

Only fragments were found of "this most delicate species of the *Obolus* sandstone." The shell appears to have been roundish and rather strongly convex, judging from one of the larger fragments, which does not exceed 5 mm. in diameter.

The species is distinguished from all others of the *Obolus* sandstone by the rounded, narrow, radiating ribs, which are increased by frequent interpolation from the umbo toward the front margin. The surface is also marked by fine concentric striation. Nothing is known of the internal characters.

Mickwitz states that this is one of the rarest of the known species of the *Obolus* sandstone.

In some collections made by Schmalensee I found nearly an entire specimen of the exterior of the ventral valve; this is illustrated by Plate XV, figure 3. The surface of this shell is much like that of *Botsfordia cælata* (Hall) (Pl. LIX, fig. 1b).

FORMATION AND LOCALITY.—**Upper Cambrian:** (**395** [*Mickwitz, 1896, p. 158*]) *Obolus sandstone at Joa, near Jegclecht, 12 miles (19.3 km.) east of Reval;* and (**395b**) *Obolus* sandstone at Ilgast; both in the Government of Esthonia, Russia.

OBOLUS FEISTMANTELI (Barrande).

Plate XII, figures 1, 1a–f, 9, 9a.

Lingula feistmanteli BARRANDE, 1879, Système silurien du centre de la Bohême, vol. 5, Pl. CVI, figs. IV: 1–14; Pl. CX, figs. VIII: 1–4. (No text reference. Pl. XII, figs. 1, 1a, 1d, and 1f of this monograph are copied from Barrande's figures, Pl. CXVI, figs. IV: 7a, 11a, 4a, and 12f, respectively.)

General form rounded ovate to rounded subtriangular; ventral valve subacuminate, with the dorsal valve rounded subacuminate; valves moderately and almost uniformly convex. Surface of the shell marked by concentric undulations and striæ of growth and, apparently, fine radiating striæ. The latter are shown only on one specimen, as the outer surface usually adheres to the sandstone matrix, as in Plate XII, figure 1a. When the outer surface of the shell is exfoliated, the surface of the inner layers is marked by numerous fine radiating striæ (Pl. XII, figs. 1 and 1f), with more or less obscured concentric lines of growth. The radiating striæ appear to be distributed over the entire surface of the inner lamellæ of the shell, but are strongest on the inner, oblique layers of the anterior portion. In some instances the striæ on the oblique lamellæ are somewhat irregular (Pl. XII, fig. 1e); the inner surface of the shell is marked by small pits or punctæ and by obscure concentric lines of growth. The punctæ are distributed irregularly, being most prominent in the visceral portion. The general character is well shown in Plate XII, figure 1f. The shell is formed of a thin outer layer, with numerous inner layers or lamellæ over the anterior and outer portions. These inner lamellæ over the anterior portion of the shell are oblique to the outer layer, and when the shell is partly exfoliated they appear as imbricating layers (Pl. XII, figs. 1 and 1f). The layers or lamellæ formed in the central and posterior portions of the shell are relatively strong, and give considerable thickness to the shell. When these are exfoliated and the oblique anterior lamellæ are preserved, a shallow but well-defined depressed rim extends all around the valves. This rim shows more or less distinctly in the cast of the interior of the shell (Pl. XII, figs. 1b and 1e). This species varies somewhat in size and outline of the valves, but the variation shown is very slight in a large series of specimens from the typical locality. A ventral valve 16 mm. in length has a width of 15 mm. A dorsal valve, represented in figure 1e, is slightly wider than long. Usually the length and width of the dorsal valves is the same.

Casts of the interior of the ventral valve show a very clearly defined area. This is rather short for so large a shell (Pl. XII, fig. 1b); it is divided midway by the cast of a narrow, rather deep, pedicle groove; flexure lines have not been observed. The area extends well forward on the cardinal slopes and is marked by strong striæ of growth parallel to its front margin. One of the casts indicates that the area formed a narrow shelf between the pedicle groove and the lateral margins. The area of the dorsal valve is short and extends but a short distance out on the cardinal slopes.

Casts of the visceral cavity are well shown for both valves (Pl. XII, figs. 1b and 1e). It resembles that of *Obolus matinalis* (Hall) and *O. apollinis* Eichwald. The median septum has not been seen in either valve. A narrow furrow extends down the center of the dorsal valve between the central scars. A similar median depression is seen in the posterior portion of the visceral cavity of the ventral valve.

The muscle scars of the ventral valve are not clearly defined. The umbonal scar is indicated in one specimen (Pl. XII, fig. 1b). It is divided, but no trace of a pedicle scar has been

seen between the two. In the dorsal valve the umbonal scar is very close to the area and extends some distance on each side of the median line. It is marked by fine striæ subparallel to the longitudinal axis of the shell. In one cast (Pl. XII, fig. 1b) the position of the transmedian and anterior lateral scars is indicated; also the area in which the central, middle, and outside lateral scars occur, but the scars are not differentiated. In the dorsal valve (Pl. XII, fig. 1e) the central (h) and anterior lateral (j) scars are clearly defined also the position of the transmedians (i).

Portions of the markings left on the shell by the vascular system are well preserved in a few specimens. The description is of the cast, or as the markings are shown on the thin inner layer. The main sinuses are slightly rounded ridges that arch from the beak outward toward the center and then inward well toward the anterior margin. Those of the ventral valve are shown in Plate XII, figures 1b, 1c, and 1d, and the dorsal in figure 1e. The interior lateral branches in the ventral valve extend transversely from the main sinus nearly to the median line, except toward the front, where they arch slightly backward (Pl. XII, fig. 1c); the exterior lateral branches arch forward to the edge of the depressed rim, where they appear to pass into the small interosculating canals that cross the rim to the outer margin, each canal dividing into three or more branches; the peripheral vascular canal of Mickwitz [1896, p. 97] does not appear on any of the specimens available for study, but this may be owing to our not having the inner surface of the inner layer to examine.

The parietal scar is distinctly shown in front of the visceral cavity in both valves, but it has not been traced outside of the main sinus, although the positions of the transmedian and anterior lateral scars in the dorsal valve (Pl. XII, fig. 1b) indicate its approximate lateral extension.

Observations.—This large fine species is extensively illustrated by Barrande, but the material at his command evidently did not satisfactorily show the muscle scars and vascular markings of the interior of the valves. One figure of the ventral valve [1879b, pl. CVI, fig. IV: 4] indicates the relative position of the main vascular canals and muscle scars (copied on Pl. XII, fig. 1d, of this monograph), but it was not sufficiently clear to convince Mickwitz [1896, pp. 19–20] that the species should be referred to *Obolus*, and Hall and Clarke [1892c, pp. 68–69] suggested that it might be an *Obolella*. I found in the collections of the Museum of Comparative Zoology at Cambridge a number of specimens showing casts of the interior of both valves. Of these, three are figured in this monograph (Pl. XII, figs. 1b, 1c, 1e, 9, and 9a). Plate XII, figure 1c, is of a specimen preserving the thin inner layer, on the exterior of which vascular markings are beautifully preserved. Owing to the coarse character of the sandstone matrix, the interior casts preserve only traces of the main sinuses. Figure 1e represents a similar specimen in which the exterior lateral branches of the main sinus appear to subdivide at the inner edge of the flattened rim and to continue across the rim to the outer edge, inosculating and bifurcating in an irregular manner.

This is one of the most recent as well as the largest species of the genus. In form and the arrangement of the vascular markings and muscle scars it may be compared with *O. matinalis* (Hall), which, however, is a much smaller species from the Middle Cambrian fauna. In outline, size, and general arrangement of the muscle scars and visceral cavity the species may be compared with *Obolus* (*Lingulobolus*) *affinis* (Billings) (Pl. XVI, figs. 1, 1a–e).

The specific name was given in honor of K. Feistmantel.

FORMATION AND LOCALITY.—**Lower Ordovician**: (**303i** [*Barrande, 1879b, Pl. CX*]) *Sandstone of Étage d1, at Kruschna Hora;* and (**303j** [Barrande, 1879b, Pl. CVI]) Étage d1, at Czerhowitz; both in Bohemia, Austria-Hungary.

OBOLUS FRAGILIS (Walcott).

Plate XXIII, figures 5, 5a–e.

Obolus (*Lingulella*) *fragilis* WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 404. (Described and discussed essentially as below as a new species.)

General form ovate, with the ventral valve subacuminate and dorsal valve broad ovate; valves apparently moderately convex, as determined from the specimens more or less compressed in the shale. Surface of shell marked by concentric lines of growth, and what appears

to be an exceedingly fine papillose surface, which is apparently produced by the inosculation of irregular, raised striæ, as on the surface of *Obolus* (*Westonia*) *ella* (Hall and Whitfield) and *Lingulella ferruginea* Salter and on a larger scale by *Lingulella radula* Matthew. When the outer layer of the shell is exfoliated, very fine concentric and radiating striæ occur on the surface of the inner layers. The shell is thin and formed of an outer layer and one or more thin layers or lamellæ.

The average length of the ventral valve is about 5 mm.; width, 4 mm. The dorsal valve is a little shorter.

The rather long area of the ventral valve is divided midway by a strong pedicle groove (Pl. XXIII, fig. 5). The area of the dorsal valve is clearly defined on casts of the interior; it is about three-fifths the width of the valve and is arched forward at the center.

The casts of the interior of the valves show traces of the vascular markings, but nothing very definite can be said of them.

Observations.—This pretty little species is closely related to *Lingulella ferruginea* Salter, with which it is associated in the shales of Manuels Brook. It is distinguished from the latter by its broad form and thinner shell.

FORMATION AND LOCALITY.—**Middle Cambrian:** (1a) Shales near the top of No. 6 of the Manuels Brook section; (1) *shales of zone A of No. 7 of the Manuels Brook section;* and (2) shales of zone B of No. 7 of the Manuels Brook section; all on Manuels Brook (see Walcott, 1891b, p. 261, for position in section), Conception Bay, Newfoundland.

OBOLUS? INFLATUS Westergård.

Obolus ? inflatus WESTERGÅRD, 1909, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 4 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 20), p. 76, Pl. V, fig. 25. (Described in Swedish as a new species; see below for translation.)

The original description by Westergård follows:

Interior of shell unknown, hence the generic identification is uncertain. The outer contour is almost elliptical, being somewhat less broad than high. The thin shiny shell is posteriorly sharply convex and slopes from there to the anterior margin. It has somewhat uneven, fine, but very distinct concentric striæ and indistinct radial striæ. Even where the shell is exfoliated the radial striation is apparent.

FORMATION AND LOCALITY.—**Passage beds** between the Upper Cambrian and the Ordovician: (**310x** [Westergård, 1909, p. 76]) The uppermost limestone stratum, in beds equivalent to the *Ceratopyge* limestone, at Jerrestad, Province of Malmöhus, Sweden.

OBOLUS ISMENE Walcott.

Plate XI, figures 3, 3a–b.

Obolus ismene WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 325. (Characterized as below as a new species.)

This species is characterized by its elevated umbo, flattened posterior lateral margins, and relatively thin shell.

All that is known of the exterior surface indicates that it was nearly smooth, marked only by fine concentric striæ of growth. The inner layers of the shell are beautifully marked by fine concentric and radiating striæ that give the surface a cancellated appearance. The shell is built up of several layers or lamellæ that become more oblique to the outer surface toward the front.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**369**) Sandstone in the Elvins formation, in the eastern limits of the town of Flat River, St. Francois County, Missouri.

OBOLUS LAMBORNI (Meek).

Plate XXII, figures 2, 2a–n.

Lingulella ? lamborni MEEK, 1871, Proc. Acad. Nat. Sci. Philadelphia for 1871, vol. 23, pp. 185–187, fig. 1. (Described and discussed as a new species.)

Lingulella lamborni Meek, KEYES, 1894, Missouri Geol. Survey, vol. 5, pt. 2, pp. 38–39, Pl. XXXV, figs. 5a–d. (Described.)

General form broadly ovate, with the ventral valve obtusely acuminate and the dorsal valve rather broadly oval; convexity apparently moderate, judging from specimens of the

shells as they occur flattened out in the argillaceous shales. Surface of the shell marked by concentric lines and striæ of growth, and fine, slightly undulating striæ in the interspaces, and fine radiating striæ; the interior surface of the shell was strongly pitted or punctate, especially in the posterior half (Pl. XXII, figs. 2, 2a, 2i, and 2j). The shell was relatively thin, and formed of a thin outer layer and one or more inner layers or lamellæ.

One of the larger ventral valves from Missouri has a length of 8.5 mm.; width, 7.5 mm., as it occurs flattened in the shale; an associated dorsal valve has a length and width of 8 mm. The average size of the specimens from Tennessee is about 7 mm. for the ventral valve; a few shells from Georgia are unusually large; one dorsal valve (Pl. XXII, fig. 2l) has a length of 15 mm., width 12 mm., in the flattened shell.

As shown in the cast the area of the ventral valve is rather long, and is divided midway by a strong pedicle furrow and marked midway between the furrow and the cardinal margins by a narrow flexure line. The striæ of growth cross the area parallel with its base and extend over the cast of the pedicle furrow; they are very fine and closely grouped together on the flexure line and on the lateral slopes. The area of the dorsal valve is rather long and extended well out onto the cardinal slopes; it is marked in several specimens by unusually strong flexure lines; the striæ of growth cross it parallel to its base, curving sharply forward at the median line. From the condition of the casts of the cardinal area it is evident that it formed in both valves a thin shelf, the undercut extending backward far under the area much as in *Lingulella ampla* (Owen) (Pl. XXVIII), *Lingulella acutangula* (Roemer) (Pl. XVII), etc.

Casts of the interior of the ventral valve (Pl. XXII, fig. 2b) show in the visceral cavity (v) traces of the heart-shaped pit (x). There are no traces of a median septum in the ventral valve, but it is shown in the casts of a dorsal valve as a very narrow, clearly defined short depression, extending from a point in front of the anterior lateral muscle scars back between the central muscle scars (Pl. XXII, fig. 2g).

Only the anterior lateral muscle scars are distinctly shown in the ventral valve. In one specimen from Tennessee the trapezoidal area (c) is well preserved, but the central scars and middle and outside laterals can not be differentiated (Pl. XXII, fig. 2f).

In the dorsal valve the central muscle scars (h), the anterior laterals (j), and the transmedians (i) are all discernible. The anterior laterals are small and situated near the center of the shell, the centrals occurring some distance back and near the median septum, somewhat as in *Lingulella ampla* (Owen) (Pl. XXVIII). Portions of the markings left on the interior of the shell by the vascular system are shown on a cast of the interior. The main or trunk sinuses are best shown in the ventral valve in specimens represented in Plate XXII, figures 2, 2a, 2b, and for the dorsal valve in figure 2i. The parietal scar (ps) is distinctly shown in front of the visceral area of the ventral valve (Pl. XXII, figs. 2 and 2b) and the dorsal valve (figs. 2g and 2h); in both valves it extends out to the main sinuses (Pl. XXII, figs. 2 and 2h), but it is not observed beyond them.

Observations.—This fine species is well characterized by the strongly pitted inner surface and the elongate visceral area of the dorsal valve. The specimens from the type locality at Mine Lamotte are usually more or less broken and crushed, but a few in the United States National Museum show the form and outline and, more rarely, traces of the interior visceral and muscle scar markings. The material from Tennessee is much more abundant and somewhat better preserved; a marked variation is shown in the size and number of the interior pits or punctæ, and a considerable range in the outline of the valves; the latter is mainly to be attributed to distortion as the result of compression and a slight movement in the shale. Most of the specimens from Tennessee are about the same size as those from Missouri, but a number of larger shells were found about 50 feet lower in the section which are nearly double the average size of the specimens from Missouri and Tennessee. I am not able to discover any other differences that lead to considering them as a distinct species. The specimens are flattened in the shale, which gives rise to more or less distortion. The most nearly related species is *Obolus willisi* (Walcott) (Pl. XXIII) of the Middle Cambrian of Tennessee. The latter differs in being shorter in proportion to its width, in the nearly transverse, obtuse posterior

margin of the dorsal valve, and in the position of the central muscle scars. Specimens from the limestone just above the shales at Mine Lamotte are moderately convex and more elongate than those compressed in the shale. Some shells suggest the outline of *Lingulella acutangula* (Pl. XVII).

FORMATION AND LOCALITY.—**Upper Cambrian**: (**7d**) Shales in second cliff 0.125 mile (0.2 km.) west of Peak, 3 miles (4.8 km.) south of Clinton, Briceville quadrangle (U. S. Geol. Survey), Anderson County; and (**122a**) shale at the headwaters of Forgey Creek, northwestern part of the Greeneville quadrangle (U. S. Geol. Survey), Hawkins County; both in Tennessee.

Middle Cambrian: (**11j**)[a] *Shale and limestone in the basal part of the Bonneterre limestone, Mine Lamotte, Madison County;* (**369f**) limestone at Fredericktown, Madison County; (**11m**) drill cores of limestone at horizons 10 and 20 feet (3 and 6 m.) above the Lamotte sandstone, St. Francois County; and (**369h**) shale at Mine Lamotte, Madison County; all in Missouri.

(**331**) Rogersville shale 1 mile (1.6 km.) south of Fletcher, Greene County, Virginia.

(**102**) Rogersville shale just south of road, one-half mile (0.8 km.) southwest of Rogersville on the road to Melinda Ferry [Keith, 1896a, areal geology sheet]; (**103**) second shale south of the ridge of sandstone in the Rome formation ("Town Knobs"), on the road from Rogersville to Dodson Ford, near the line between the Morristown and Greeneville quadrangles (U. S. Geol. Survey); (**121**) Rogersville shale, road just east of Harlan Knob, 4 miles (6.4 km.) northeast of Rogersville [Keith, 1905, areal geology sheet]; (**101b**) Rogersville shale, just east of the schoolhouse, 3.5 miles (5.6 km.) southwest of Rogersville on the road to Melinda Ferry [Keith, 1896a, areal geology sheet]; and (**124a**) shales (Nolichucky?) overlying the limestone which rests on the Rogersville shale, on Big Creek, southeast of Harlan Knob, 4 miles (6.4 km.) northeast of Rogersville [Keith, 1905, p. 4, and areal geology sheet]; all in Hawkins County, Tennessee.

(**140a**) Shales 200 yards (182.9 m.) east of Thomas Mills, 5 miles (8 km.) north of Cave Spring [Hayes, 1902, historical geology sheet], Floyd County, Georgia.

OBOLUS LAMBORNI MINIMUS (Walcott).

Plate XXV, figures 4, 4a–b.

Obolus (*Lingulella*) *lamborni minimus* WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 407. (Discussed as below as a new variety.)

This variety in its ventral valve closely resembles the adult form of the ventral valve of *Obolus lamborni* (Meek). The dorsal valve also has the same general form as most of the dorsal valves of the species. In comparing, however, the young specimens of the same size with the variety *minimus* the ventral valves appear to be more obtuse in the young of *O. lamborni*.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**101** and **101a**)[b] *Rogersville shale, just above the road in the hill west of the schoolhouse, 3.5 miles (5.6 km.) southwest of Rogersville on the road to Melinda Ferry [Keith, 1896a, areal geology sheet], Hawkins County;* (**103a**) upper part of the second shale south of the ridge of sandstone in the Rome formation ("Town Knobs"), on the road from Rogersville to Dodson Ford, near the line between the Morristown and Greeneville quadrangles (U. S. Geol. Survey), Hawkins County; (**124**) shales (Nolichucky?) overlying limestone which rests on Rogersville shale, on Big Creek, southeast of Harlan Knob, 4 miles (6.4 km.) northeast of Rogersville [Keith, 1905, p. 4, and areal geology sheet], Hawkins County; and (**118**) shales on the Tazewell road, 2 miles (3.2 km.) north of Knoxville, Knox County; all in Tennessee.

OBOLUS LOPERI Walcott.

Plate IX, figures 4, 4a.

Obolus loperi WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 389–390. (Described and discussed as below as a new species.)

General form subsemicircular, with the ventral valve subacuminate and the dorsal valve broad ovate to circular in outline. Some of the shells are more elongate than in what is considered to be the typical form. This type of variation is also observed in *O. matinalis* (Hall) (Pl. VIII) and other species of the genus. Valves moderately convex as they occur in the sandstone. Surface of the shell marked by concentric lines and fine striæ of growth and very narrow radiating undulations that are more or less interrupted by the concentric lines of growth.

[a] Locality **11j** is given as the type locality, though the type specimens were collected from the Mine Lamotte locality long before the collection to which this number was assigned. The two localities are believed to be the same.

[b] **101a** is the type locality.

When the outer layer of the shell is exfoliated, the inner layers are seen to be marked by numerous fine, rounded, radiating striæ in addition to the concentric lines of growth; exceedingly fine, irregular, interrupted striæ give it in places a pitted appearance, while in a different light it appears to be granulated, a feature of the surface that seems to be present on all of the inner lamellæ; sometimes the impression given is that the shell is minutely punctate.

The markings of the interior, so far as known, are rounded radiating striæ. The shell is rather thick and built up of a thin outer layer and several inner layers or lamellæ that in the anterior portions of the shell are rounded obliquely to the outer surface.

The largest shell in the collection is a somewhat imperfect dorsal valve 8 mm. in length. A smaller valve, 6 mm. in length, has the same width. A ventral valve 6 mm. in length has the portion about the beak broken away and is a little longer than wide.

The only trace of the interior of the valves is a partial cast of the dorsal valve. This shows that the anterior lateral muscle scars were situated on the anterior portion of the valve about one-third the length of the shell from the anterior margin.

Observations.—This species resembles in many respects *O. matinalis* (Hall), especially the Texan form referred to that species. The material is poorly preserved, but it appears to be clearly distinct from any described species. Its surface characters are like those of *Obolus prindlei* (Walcott) (Pl. XXVII).

The species is named in recognition of the difficult and persevering work of Mr. S. Ward Loper, curator of the museum of Middlebury College, who made a large collection of fossils under the most adverse circumstances in the mountains of Colorado.

Formation and locality.—**Passage beds** between the Upper Cambrian and the Ordovician: (335a) Reddish sandstone on Cement Creek, 3 miles (4.8 km.) north of Hot Springs and 8 to 10 miles (12.8–16 km.) southeast of Crested Butte, Ouray County, Colorado.

Obolus mcconnelli (Walcott).

Plate XXIII, figures 3, 3a (not 3b–d).[a]

Lingulella mcconnelli Walcott, 1889, Proc. U. S. Nat. Mus., vol. 11, p. 441. (Described as a new species.)

Lingulella macconnelli Walcott, Matthew, 1902, Trans. Roy. Soc. Canada, 2d ser., vol. 8, sec. 4, No. 3, p. 108. (Original description copied and species discussed.)

Obolus mcconnelli Walcott (in part), 1908, Canadian Alpine Journal, vol. 1, No. 2, p. 244, Pl. I, fig. 2 (not fig. 2a, referred in this monograph to *Obolus septalis*). (No text reference. Fig. 2 is copied in this monograph, Pl. XXIII, fig. 3a.)

General form elongate ovate with the ventral valve subacuminate and rather broadly rounded in front and obtusely rounded posteriorly. When the dorsal valve is crushed and flattened in the shale it is broadly ovate. As far as can be determined from the somewhat compressed shells the valves were moderately convex. Surface of the shell marked by concentric lines of growth and fine, irregular striæ that are more or less transverse and apparently imbricating, giving a surface a little suggestive of *Obolus* (*Westonia*) *aurora* (Hall). When the outer layer is exfoliated the surface of the inner layer is marked by concentric and radiating striæ. The interior surface is marked by rather strong radiating striæ and scattered punctæ. The shell is thick for one of its size. It is formed of a thin outer layer, several thin inner layers, and numerous lamellæ in the anterior half of the valves. The only interior vascular markings seen are those of the visceral cavity and main vascular sinuses of the ventral valve.

Observations.—Since the original description [Walcott, 1889c, p. 441] was written a few specimens have been secured that add a little to the data for the description of the species.

The broad subtrigonal form represented in Plate XXIII, figure 3a, occurs on the same slab of shaly limestone with the more elongate shell represented in figure 3. The latter is compressed laterally, which makes it appear more elongate and also strengthens the radiating striæ.

A small shell from Big Cottonwood Canyon, southeast of Salt Lake City, Utah, provisionally referred to *Lingulella helena* (Walcott) (Pl. XXIV, fig. 3d), may prove to belong to this species.

[a] Figures 3b and 3c represent specimens of *Obolus mcconnelli pelias*. Figure 3d represents a specimen of *Obolus septalis*.

At most localities this species occurs within 200 feet of the base of the Middle Cambrian. In the House Range section of Millard County, Utah. however, it has been found at about 1,500 feet above the Middle Cambrian, and at other localities a very closely allied form, which was originally described as a species, "*Obolus* (*Lingulella*) *pelias*" [Walcott, 1905a, p. 330], occurs in the middle portion of the Middle Cambrian and extends into the Upper Cambrian. This I have now designated as the variety *pelias*. Another variety, *decipiens*, occurs in the Upper Cambrian.

The variety *pelias*, as a whole, is slightly narrower in the dorsal valve and somewhat more obtuse in the ventral valve. The variety *decipiens* is still shorter and broader in proportion as compared with the typical *Obolus mcconnelli*.

This is one of the most persistent forms in the Middle Cambrian section of the Cordilleran region, ranging, as it does, with its two varieties, from near the base of the Middle Cambrian well up into the Upper Cambrian or through 4,500 feet of limestone. It also has a wide geographic distribution in the Cordilleran region, extending from British Columbia to southeastern California.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**14s**) *About 2,300 feet (701 m.) above the Lower Cambrian and 2,700 feet (823 m.) below the Upper Cambrian, in the Ogygopsis zone of the Stephen formation [Walcott, 1908f, p. 210], at the great "fossil bed" on the northwest slope of Mount Stephen, above Field, on the Canadian Pacific Railway;* (**57f**) about 2,200 feet (670.6 m.) above the Lower Cambrian and 2,800 feet (853.4 m.) below the Upper Cambrian, in the limestones forming 1 of the Stephen formation [Walcott, 1908f, p. 209], about 0.5 mile (0.8 km.) east of the "fossil bed" on the northwest slope of Mount Stephen, above Field, on the Canadian Pacific Railway; (**58j**) about 1,900 feet (579 m.) above the Lower Cambrian and 3,100 feet (945 m.) below the Upper Cambrian, near the base of the limestone forming 2 of the Stephen formation [Walcott, 1908c, p. 238 (7)], on the east side of Mount Stephen about 3,000 feet (914 m.) above the Canadian Pacific Railway track 3 miles (4.8 km.) east of Field; and (**58r**) about 1,800 feet (548.6 m.) above the Lower Cambrian and 3,200 feet (975.4 m.) below the Upper Cambrian, in the limestones forming 2 of the Stephen formation [Walcott, 1908f, p. 211], in the amphitheater between Mounts Stephen and Dennis, above Field on the Canadian Pacific Railway; all in British Columbia, Canada.

(**35g**)[a] About 4,100 feet (1,250 m.) above the Lower Cambrian and 860 feet (262 m.) below the Upper Cambrian in the shaly limestones in 2 of the Eldon limestone [Walcott, 1908f, p. 209 ("*Lingulella* sp.")], at the north end of the amphitheater northwest of the main ridge of Mount Bosworth; and (**57c** and **57k**) about 2,500 feet (762 m.) above the Lower Cambrian and 2,475 feet (754 m.) below the Upper Cambrian in the limestone forming 1 of the Stephen formation [Walcott, 1908f, p. 209], on Mount Bosworth; both north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide between British Columbia and Alberta, Canada.

(**58i** and **58w**) About 1,225 and 1,300 feet (373 and 396 m.), respectively, above the Lower Cambrian in the shales of the Stephen formation [Walcott, 1908a, p. 3], northeast slope of Castle Mountain facing the amphitheater, north of the Canadian Pacific Railway, Alberta.

(**3j**) Above the quartzitic sandstones in a shale corresponding in position to the upper part of shale No. 6 of the Dearborn River section [Walcott, 1908f, p. 202], about 6 miles (9.6 km.) west-northwest of Scapegoat Mountain on the Continental Divide between Bar Creek and the headwaters of the south fork of North Fork of Sun River, Coopers Lake quadrangle (U. S. Geol. Survey), Powell County, Montana.

(**31c**) About 900 feet (274.3 m.) above the Brigham quartzite and 3,300 feet (1,005.8 m.) below the Upper Cambrian, in the limestone forming 1b of the Ute limestone [Walcott, 1908f, p. 196]; and (**54p**) about 525 feet (160 m.) above the Brigham quartzite and 3,665 feet (1,127.1 m.) below the Upper Cambrian in the shales forming 2f of the Ute limestone [Walcott, 1908f, p. 197]; both in Blacksmith Fork Canyon about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

(**34n**) Shales about 100 feet (30.5 m.) above the Tintic quartzite [G. O. Smith, 1900, p. 1], near the summit of the ridge between Mammoth and Eureka; and (**34s**) about 1,700 feet (518 m.) above the Tintic quartzite in the Mammoth limestone of G. O. Smith [1900, p. 1, and historical geology sheet], in the saddle above and a little east of the Centennial Eureka mine, near the summit of the ridge between Mammoth and Eureka; both in the Tintic special quadrangle (U. S. Geol. Survey), Juab County, Utah.

(**30p**) About 125 feet (38 m.) above the Cambrian quartzitic sandstones, on the north side of Ogden Canyon, about 1 mile (1.6 km.) above its mouth, east of Ogden, Weber County; and (**31y**) thin-bedded limestone about 125 feet (38 m.) above the Cambrian quartzitic sandstones in the Wasatch Mountains, 1 mile (1.6 km.) northwest of Geneva (Copenhagen), east of Brigham, Boxelder County; both in Utah.

(**10y**) About 2,900 feet (884 m.) above the Lower Cambrian and 1,500 feet (457.2 m.) below the Upper Cambrian in the central part of the limestone forming 1a of the Marjum limestone [Walcott, 1908f, p. 179], about 1 mile (1.6 km.) south-southwest of Marjum Pass; and (**14v**) shales of unknown stratigraphic horizon collected 1 mile (1.6 km.) south of Rainbow Valley; both in the House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah.

(**8m**) Limestone near the south end of the high ridge 4 miles (6.4 km.) northeast of Osceola; and (**10w**) shaly limestones about 5 miles (8 km.) northeast of Osceola, on the east side of the Snake Range; both in White Pine County, Nevada.

[a] This species is somewhat doubtfully identified from this locality.

(14n) Limestone about 310 feet (94.5 m.) above the Lower Cambrian on the east side of the pass about 7 miles (11.2 km.) east of Resting (Freshwater) Springs, which is in the southwest corner of T. 21 N., R. 8 E., on Amargosa River, in the southeastern part of Inyo County, California.

Middle? Cambrian: (32k) Limestones about 1,550 feet (472.4 m.) above the top of the quartzitic sandstones 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range, Tooele County, Utah.

Obolus mcconnelli decipiens n. var.

Plate XXIII, figures 4, 4a–b.

A form that appears to be a broad variety of *Obolus mcconnelli* (Walcott) occurs abundantly in the arenaceous shales and interbedded limestone of the Upper Cambrian of the Silver Peak Range, Esmeralda County, Nevada. Most of the material is badly preserved, and some of the specimens afford fine illustrations of distortion of outline by compression. The variety differs from the species in being uniformly broader and also in having more strongly marked concentric striæ. It differs from the variety *pelias* in being of an average greater proportional width.

Formation and locality.—**Upper Cambrian**: Emigrant formation [Turner, 1902, p. 265] at the following localities: (7v) *shales 4.25 miles (6.8 km.) south-southeast of Emigrant Peak;* (7x) limestone about 2.5 miles (4 km.) southeast of Emigrant Pass; and (8r) shales about 8 miles (12.8 km.) southeast of Emigrant Peak; all in the Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County, Nevada.

Middle Cambrian: (7r) Calcareous shales 4 miles (6.4 km.) south-southeast of Emigrant Peak, Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County; and (8m) limestone near the south end of the high ridge 4 miles (6.4 km.) northeast of Osceola, White Pine County; both in Nevada.

(14n) Limestone about 310 feet (94.5 m.) above the Lower Cambrian on the east side of the pass about 7 miles (11.2 km.) east of Resting (Freshwater) Springs, which is in the southwest corner of T. 21 N., R. 8 E., on Amargosa River, in the southeastern part of Inyo County, California.

Obolus mcconnelli pelias (Walcott).

Plate XXIII, figures 3b, 3c; Plate XXXIX, figures 5, 5a–c.

Obolus (Lingulella) pelias Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 330–331. (Described and discussed as a new species.)

This form was originally described [Walcott, 1905a, pp. 330–331] as a distinct species, but, with the large collections obtained in 1906 from various horizons of the Middle Cambrian, it is found to have close relations to *Obolus mcconnelli* of the lower portion of the Middle Cambrian. It ranges from about the central portion of the Middle Cambrian up into the Ordovician.

The variety differs from *O. mcconnelli* in being proportionally shorter and broader, and from the variety *decipiens*, of the Upper Cambrian, in being, on the average, slightly narrower.

The outer surface of the shell is marked by clearly defined concentric lines that are slightly irregular, and narrow, fine, radiating undulations or costæ toward the frontal margins. When unusually well preserved, the surface also shows very fine, irregular, concentric striæ between the concentric lines. The inner lamellæ of the shell are marked by fine radiating striæ and the inner surface by more or less numerous punctæ. For its size the shell may be considered as relatively thin.

Formation and locality.—**Upper Cambrian**: (54r) Drift pieces of limestone from the west slope of the Wasatch Range; and (34q) shales about 3,800 feet (1,158.2 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], in Wasatch Canyon; both east of the Lakeview Ranch, about 5 miles (8 km.) north of Brigham, Boxelder County, Utah.

(32g) About 2,575 feet (784.9 m.) above the Cambrian quartzitic sandstones in a blue limestone about 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range, Tooele County; (33d) thin-bedded blue limestone at the base of the first high point southwest of the J. J. Thomas ranch, on the east side of the Fish Spring Range, Juab County; and (30j) about 950 feet (289.6 m.) above the Middle Cambrian and 2,450 feet (746.8 m.) below the top of the Upper Cambrian near the base of the arenaceous shales and limestones forming 1e of the Orr formation [Walcott, 1908f, p. 176], on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County; all in Utah.

(7s) Shale of the Emigrant formation [Turner, 1902, p. 265], 4 miles (6.4 km.) south-southeast of Emigrant Peak, Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County, Nevada.

Middle Cambrian: (8j) About 575 feet (175.3 m.) above the unconformable base of the Cambrian in a shale which corresponds in position to shale No. 4 of the Dearborn River section [Walcott, 1908f, p. 202], on the ridge between

Gordon and Youngs creeks, about halfway between Gordon Mountain and Cardinal Peak, Ovando quadrangle (U. S. Geol. Survey), Powell County, Montana.

(**15p**) Limestones near the north end of the Fish Spring Range, Tooele County; and (**15x**) limestones near the middle of the Fish Spring Range, near the line between Juab and Tooele counties; both in Utah.

(**11n**) About 3,000 feet (914.4 m.) above the Lower Cambrian and 1,400 feet (426.7 m.) below the Upper Cambrian in the upper part of the limestone forming 1a of the Marjum limestone [Walcott, 1908f, p. 179], in the long cliff 2 miles (3.2 km.) southeast of Marjum Pass; (**11o**) about 2,750 feet (838.2 m.) above the Lower Cambrian and 1,650 feet (502.9 m.) below the Upper Cambrian, at the base of the limestone forming 1a of the Marjum limestone [Walcott, 1908f, p. 179], about 4 miles (6.4 km.) southeast of Antelope Springs in the spur at the junction of the Deseret and Swasey Spring roads; (**11q** and **30g**)[a] *about 2,350 feet (716.3 m.) above the Lower Cambrian and 2,050 feet (624.8 m.) below the Upper Cambrian in the limestone forming 1c of the Marjum limestone [Walcott, 1908f, p. 180], ridge east of Wheeler Amphitheater;* (**3x** and **3y**) about 2,200 feet (670.6 m.) above the Lower Cambrian and 2,200 feet (670.6 m.) below the Upper Cambrian in the limestones forming 1d of the Marjum limestone [Walcott, 1908f, p. 180], ridge east of Wheeler Amphitheater; (**3s** and **8g**) about 1,700 feet (518.2 m.) above the Lower Cambrian and 2,700 feet (823 m.) below the Upper Cambrian in the shaly limestones and calcareous shales of the Wheeler formation [Walcott, 1908f, p. 181], in the eastern part of Wheeler Amphitheater east of Antelope Springs; (**8i**) shales believed to be referable to the lower portion of the Marjum limestone [Walcott, 1908f, p. 180], found about 0.5 mile (0.8 km.) east of Antelope Springs; and (**8k**) shales 0.5 mile (0.8 km.) northwest of Tyler Springs, east slope of House Range east of Antelope Springs; all in the House Range [Walcott, 1908f, Pls. XIII and XV], Millard County, Utah.

(**54h**) About 3,140 feet (957.1 m.) above the Brigham quartzite and 1,050 feet (320 m.) below the Upper Cambrian in the limestones forming 1a of the Bloomington formation [Walcott, 1908f, p. 194], in Blacksmith Fork Canyon, about 9 miles (14.4 km.) east of Hyrum, Cache County, Utah.

Middle? Cambrian: (**34v**) Limestone about 1,750 feet (533 m.) above the Cambrian quartzitic sandstones about 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range, Tooele County, Utah.

Obolus mæra (Hall and Whitfield).

Plate X, figures 2, 2a–e.

Lingulepis mæra Hall and Whitfield, 1877, U. S. Geol. Expl. 40th Par., vol. 4, p. 206, Pl. I, figs. 5–7. (Described and discussed as a new species. The specimens represented by figs. 6 and 5 are redrawn in this monograph, Pl. X, figs. 2a and 2b, respectively.)

Lingulepis mæra Hall and Whitfield, Walcott, 1884, Mon. U. S. Geol. Survey, vol. 8, pp. 12–13. (New localities mentioned.)

Lingulella? mæra (Hall and Whitfield), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 61. (Suggests change in generic reference.)

Lingulella? mæra (Hall and Whitfield), Walcott, 1897, Am. Jour. Sci., 4th ser., vol. 3, p. 404. (Merely changes generic reference.)

Obolus (*Lingulella*) *mæra* (Hall and Whitfield), Walcott, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, p. 443. (Merely changes generic reference.)

General form round ovate, with the ventral valve broadly subacuminate and the dorsal valve obtusely rounded; valves rather strongly convex, the convexity increasing gradually from the margins to the umbonal portion of the shell, where it is greatest. Surface marked by concentric lines and fine striæ of growth and very fine indistinct radiating striæ that can be seen only with a strong glass in a reflected light. When the outer layer of the shell is exfoliated the surface is marked by numerous radiating striæ, becoming coarser toward the front, where they outline narrow, slightly raised ribs; this latter feature varies from simple radiating striæ to the appearance of narrow ribs; the interior surface has not been seen. The shell is formed of a rather thin outer layer and numerous inner layers, which make a strong, thick shell; the inner lamellæ over the anterior portions of the shell are oblique to the outer layer and when the shell is partly exfoliated appear as imbricating layers. A small ventral valve 10 mm. in length has a width of 8 mm. A larger associated dorsal valve has a length of 11 mm., width of 10 mm.

The only portion of the interior of the shell thus far discovered is an imperfect cast of a portion of the area of a ventral valve (Pl. X, fig. 2).

Observations.—This species is most nearly related to *O. matinalis* (Hall) (Pl. VIII). It differs from that in being somewhat more elongate, although some examples vary but little from *O. matinalis*. The fact that it occurs in the Upper Cambrian near the base of the Ordovician has more influence in leaving it as a distinct species than any differences which have been thus far observed.

[a] **11q** is the type locality.

The species is quite widely distributed. The type came from the thin-bedded limestones in the Dunderberg shale, at the summit of the Cambrian in the Eureka district, Nevada. T. W. Stanton found what appears to be the same species in sandy shales and sandstones at Glenwood Springs, Colorado. A partly exfoliated, somewhat distorted ventral (?) valve from an Upper Cambrian limestone one mile south-southwest of Highgate Falls, Vermont, appears to be identical with *O. mæra*.

FORMATION AND LOCALITY.—**Passage beds** between the Upper Cambrian and the Ordovician: (**205**) Siliceous limestone on Roundtop Mountain, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

Upper Cambrian: (**313j** [*Hall and Whitfield, 1877, pp. 205 and 206*]) *Limestone in the Eureka district;* and (**61**) limestones in the Dunderberg shale [Walcott, 1908f, p. 184], a little south of the Hamburg mine; both in the Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

(**360h**) Sandy shales about 200 feet (61 m.) above the base of the section at Glenwood Springs; and (**360i**) Sandstone about 100 feet (30.5 m.) above the base of the section at Glenwood Springs; both in Garfield County, Colorado.

Middle Cambrian: (**58**) shaly limestones in upper beds of Secret Canyon shale, east side of New York and Secret canyons, Eureka County, Nevada.

A specimen that is somewhat doubtfully referred to *Obolus mæra* occurs at the following locality:

Upper Cambrian: (**319q**) Limestone 1 mile (1.6 km.) south-southwest of Highgate Falls, Franklin County, Vermont.

OBOLUS MATINALIS (Hall).

Plate VIII, figures 1, 1a–k.

Orbicula prima OWEN, 1852, Rept. Geol. Survey Wisconsin, Iowa, and Minnesota, p. 583, Pl. I B, figs. 13 and 16–19. (Described as a new species.)

Lingulepis pinnaformis HALL (in part) [not (OWEN)], 1863, Sixteenth Ann. Rept. New York State Cab. Nat. Hist., pp. 129–130, Pl. VI, figs. 12 and 13 (not figs. 14–16, referred to *Lingulella* (*Lingulepis*) *acuminata*). (The specimens represented by figs. 12, 13, and 15 are referred with doubt to "*Lingulepis pinnaformis*" and the name *matinalis* is proposed for them on p. 130 in the event of their proving distinct. The specimen represented by fig. 15 is a dorsal valve of the true "*Lingulepis pinnaformis*"=*Lingulella* (*Lingulepis*) *acuminata*. See following reference.)

Lingulepis matinalis HALL, 1863, idem, p. 130, Pl. VI, figs. 12 and 13 (not fig. 15, referred to *Lingulella* (*Lingulepis*) *acuminata*). (The specific name *matinalis* is proposed for the forms represented by figs. 12, 13, and 15 should they prove distinct from those represented by figs. 14 and 16. See preceding reference.)

Lingulepis pinnaformis HALL (in part) [not (OWEN)], 1867, Trans. Albany Inst., vol. 5, p. 107, Pl. I, figs. 12 and 13 (not figs. 14–16). (Copy of Hall, 1863, pp. 129–130, Pl. VI, figs. 12 and 13; see note following citation above.)

Lingulepis matinalis HALL, 1867, idem, p. 107, Pl. I, figs. 12 and 13 (not fig. 15). (Copy of Hall, 1863, Pl. VI, figs. 12 and 13; see note following citation above.)

Lingulella? matinalis (Hall), WALCOTT, 1897, Am. Jour. Sci., 4th ser., vol. 3, p. 404. (Merely changes generic reference.)

Obolus (*Lingulella*) *matinalis* (Hall), WALCOTT, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, p. 443. (Merely changes generic reference.)

General form rounded ovate, with the ventral valve broadly subacuminate and the dorsal valve obtusely rounded; valves rather strongly convex, convexity increasing gradually from the margins to the central portion of the shell. Surface of the shell marked by concentric lines and striæ of growth and faint interrupted radiating striæ; the finer concentric striæ fill in the interspaces between the lines of growth. When the outer layer of the shell is exfoliated, the surface is marked by numerous fine, radiating striæ (Pl. VIII, fig. 1a), and with more or less obscure concentric lines of growth; the radiating striæ are particularly strong over the anterior portion of the inner oblique layers or lamellæ of the shell. As far as can be determined from the casts of the inner surface it was marked by concentric lines of growth and strong, radiating, flattened striæ (Pl. VIII, fig. 1e). The shell is formed of a thin outer layer and numerous inner layers or lamellæ over the anterior and outer portions; these inner lamellæ over the anterior portions of the shell are oblique to the outer layer, and when the shell is partly exfoliated they appear as imbricating layers, as shown by Plate VIII, figure 1c; the layers of lamellæ over the umbo and central portions are strong and give a considerable thickness to the shell. The species vary somewhat in size and in the outline of the valves, as may be seen by comparing the various figures. A ventral valve 11 mm. in length has a width of 11.5 mm.; another ventral

valve 11.5 mm. in length has a width of 11 mm. A dorsal valve 9 mm. in length has a width of 9 mm.; another dorsal valve 11 mm. in length has a width of 12 mm.

Casts of the interior of the ventral valve show a very clearly defined area of medium length (Pl. VIII, fig. 1d); it is divided midway by the cast of a strong pedicle groove and about halfway between the groove and the lateral margin by a distinct flexure line; striæ of growth cross the area parallel with its front margin, being flexed on the flexure line and arching over the cast of the pedicle groove. None of the casts show whether the area formed a shelf between the pedicle groove and the lateral margins, as in most species of the genus *Lingulella*. The area of the dorsal valve is short and relatively narrow, extending about halfway out on the cardinal slopes.

The cast of the visceral cavity of the ventral valve is well shown by several specimens (Pl. VIII, figs. 1d and 1e). It resembles that of *Obolus apollinis quenstedti* (Mickwitz) in having the anterior margins extending almost directly outward from the center toward the impressions of the main vascular sinuses. There are no traces of a median septum in the ventral valve; in the dorsal valve it is shown in the cast as a very narrow depression and between and a little forward of the central muscle scars (Pl. VIII, fig. 1h). The thickening of the shell at the anterior margin of the visceral cavity of the ventral valve is quite marked, as shown in Plate VIII, figure 1f.

The muscle scars are well shown in one specimen of the ventral valve (Pl. VIII, fig. 1f). The central (h), middle (k), and outside lateral (l) scars occur, but usually the scars can not be differentiated. The anterior lateral (j) and transmedian (i) scars are also quite distinctly shown. In the dorsal valve (Pl. VIII, fig. 1h) the central (h) and anterior lateral (j) scars are clearly defined, also the transmedian (i) scars. Of the markings left on the shell by the vascular system the main vascular sinuses are usually well shown in the casts, and in one specimen of the ventral valve both the inner and lateral branches are finely outlined (Pl. VIII, fig. 1d).

The parietal scar (ps) is nearly transverse in front of the visceral area of the ventral valve; it arches forward at the center and curves a little backward toward the main vascular sinuses. Its course outside of the latter is partly shown by Plate VIII, figure 1d. In the dorsal valve its course may be followed from the median line in front of the anterior lateral scars to the outward curve of the trunk sinuses, beyond which it can not be traced with any degree of certainty.

Observations.—This species has not heretofore been well described or illustrated. Hall [1863, p. 130] noticed that there were certain ovate shells associated with "*Lingulepis pinnaformis*" which had a smooth, glossy surface, with fine concentric striæ, and that when the outer surface was removed it was very distinctly striated by fine, somewhat bifurcating striæ. In accordance with the system in vogue at that time he proposed, in event of the form proving to be a distinct species, to have it called *Lingulepis matinalis*. A smaller shell occurs in association with *Dicellomus politus* (Hall) at Eau Claire, Wisconsin, that appears to be identical with *O. matinalis*. It differs in having smaller central muscle scars in the dorsal valve, but, as the variation in form and size of the muscle scars is often considerable in shells of the same species, this is not considered sufficient for specific differentiation.

The Texas shells from Packsaddle Mountain (Pl. VIII, figs. 1l–o) are smaller than the typical Wisconsin forms, and are identified with *Obolus tetonensis ninus* (Pl. XI, figs. 1, 1a–g). The specimens represented in Plate VIII, figures 1b, 1e, and 1h, are larger and more readily identified with the species. A single ventral valve from the Bighorn Mountains is similar in form to ventral valves from Texas. At La Crosse, Wisconsin, the shells are smaller and occur about 200 feet below the base of the arenaceous limestone of the Ordovician.

This species appears to be distinct from any described form. It approaches most nearly to *O. mæra* (Hall and Whitfield), differing from the latter in being slightly less elongate.

FORMATION AND LOCALITY.[a]—**Lower Ordovician:** (360a) Red siliceous limestone on west side of Trout Creek below Bergen Park, 7 miles (11.2 km.) north-northwest of Manitou, El Paso County, Colorado.

Upper Cambrian: (302d) Limestone 200 yards (183 m.) north of the southwest corner of sec. 18, T. 28 N., R. 113 W., Uinta County, Wyoming.

[a] Owen [1852, p. 583] gives the type locality as "falls of the St. Croix, Minnesota;" this might be compared with our localities 328h, 82s, and 328e, all in Wisconsin.

(82b) "St. Croix sandstone" along the railroad track near Taylors Falls, Chisago County; (339d) "St. Croix sandstone" at Taylors Falls, Chisago County; (339f) "St. Croix sandstone" near Minneiska (Miniska) on Mississippi River near the line between Wabasha and Winona counties; (97b) "St. Croix sandstone" below the green-sand bed and 25 feet (7.6 m.) above St. Croix River at Franconia, Chisago County; and (339h [Hall, 1863, p. 130]) "St. Croix sandstone" at the mouth of Minneiska (Miniska) River, near the line between Wabasha and Winona counties; all in Minnesota.

(328h) Silico-calcareous layers of F1b of Owen [1852, p. 583], at the falls of St. Croix River, Polk County; (100) "St. Croix sandstone" near Menomonie, Dunn County; (134) "St. Croix sandstone" in the lowest beds exposed along the banks of Red Cedar River, opposite Menomonie, Dunn County; (82a) "St. Croix sandstone" 25 feet (7.6 m.) above the water level near the Knapp, Stout and Company's buildings, Menomonie, Dunn County; (82s) "St. Croix sandstone" on the bank of St. Croix River at St. Croix Falls, Polk County; (79, 79′, and 79b) "St. Croix sandstone" near Hudson, St. Croix County; (83) "St. Croix sandstone" near Trempealeau, Trempealeau County; (78d) upper portion of "St. Croix sandstone" exposed in the bluffs at La Crosse, La Crosse County; and (98 and 98x) "St. Croix sandstone" near Eau Claire, Eau Claire County; all in Wisconsin.

(9t) About 170 feet (52 m.) above the porphyry contact in the limestones of the Reagan sandstone, SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W., 15 miles (24.2 km.) northwest of Fort Sill, Comanche County, Oklahoma.

(14e) Limestone in Bartlett Hollow, 2 miles (3.2 km.) southeast of the mouth of Falls Creek, Burnet quadrangle (U. S. Geol. Survey), Lampasas County; (68 and 68z) limestone on Packsaddle Mountain, Llano County; (14b) limestone on Cold Creek at north end of gorge opposite the north end of Sponge Mountain, 2 miles (3.2 km.) south of the San Saba County line, in Llano County; (14c) upper part of the limestone exposed at Baldwin's ranch, on Cold Creek, 2.5 miles (4 km.) south of the San Saba County line, in Llano County; (67, 67c, and 67z) sandstone on Tatur Hill, 7 miles (11.2 km.) northwest of Burnet, Burnet County; (14q) sandstone in Bartlett Hollow, 1.5 miles (2.4 km.) southeast of the mouth of Falls Creek, Burnet quadrangle (U. S. Geol. Survey), Lampasas County; (14r) lower 50 feet of sandstone on Colorado River, 3 miles (4.8 km.) south of the northeast corner of Llano County; and (71) limestone in Cold Creek Canyon, Burnet County; all in Texas.

(92b) On Buffalo Creek, 2 miles (3.2 km.) southeast of Buffalo Mills, Rockbridge County, Virginia.

Middle Cambrian: (302) Limestone east of West Gallatin (Gallatin) River, above Gallatin, Gallatin County, Montana.

(170) Sandstone about 10 miles (16.1 km.) south-southeast of Bald Mountain, Bighorn Mountains, Wyoming.

(56f) Nounan limestone [Walcott, 1908a, p. 6], on a ridge north of the creek which flows into Mill Canyon from the west, about 5 miles (8 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho.

(3e) Thin-bedded limestone less than 400 feet (121.9 m.) above the quartzitic sandstones of the Cambrian, at Ophir, Oquirrh Range, Tooele County, Utah.

(328e) "St. Croix sandstone" at St. Croix Falls, Polk County; and (83[4]) St. Croix sandstone at Trempealeau, Trempealeau County; both in Wisconsin.

Specimens somewhat doubtfully referred to *Obolus matinalis* occur at the following localities:

Upper Cambrian: (11d) Arenaceous limestone about 2 miles (3.2 km.) north of Montana, in sec. 22, T. 35 N., R. 1 E., Iron County, Missouri.

Middle Cambrian: (319s) "St. Albans formation" at St. Albans, Franklin County, Vermont.

(11e) Thin-bedded limestones south-southwest of Potosi, Washington County, Missouri.

Obolus matinalis (Hall)?

Plate VIII, figures 3, 3a.

(For synonymy of *Obolus matinalis*, see page 400.)

Obolus matinalis (Hall)?, Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 325. (Mentioned as below.)

A form indistinguishable from this species occurs in China in a gray limestone of Upper Cambrian age. Only the general form of partly exfoliated shells is known.

Formation and locality.—**Upper Cambrian:** (C54) Lower part of Chaumitien limestone [Blackwelder, 1907a, p. 42 (part of last list of fossils)], near top of limestone knoll, 0.66 mile (1.1 km.) west of Tsinan, Shantung, China.

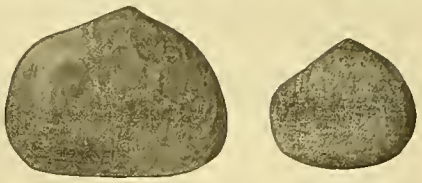
Obolus membranaceus Walcott.

Text figures 36A–B, page 403.

Obolus membranaceus Walcott, 1908, Smithsonian Misc. Coll., Vol. LIII, No. 3, p. 61, Pl. VII, fig. 11. (Characterized and discussed as below as a new species. Fig. 11 is copied as fig. 36A in this monograph.)

In size and outline this species is somewhat similar to *Obolus feistmanteli* (Barrande) (Pl. XII, figs. 1, 1a–c), but in its very thin almost membranaceous shell it differs from that species and

all other species of the genus known to me. Seven specimens were collected from a shaly compact limestone, all as casts. Remnants of the corneous shell are preserved, which show it to have been very thin, and the interior casts show that it did not retain any impressions of the animal sufficiently strong to be impressed on the cast. A short, rather narrow cardinal area occurs on both the ventral and dorsal valves. Outer surface smooth, with a few lines of growth. The largest ventral valve has a length of 17 mm. and a width of 22 mm. A less distorted dorsal valve has the same length and width, 15 mm.



A B

FIGURE 36.—*Obolus membranaceus* Walcott. A, Cast of ventral valve (U. S. Nat. Mus. Cat. No. 53674a). B, Cast of dorsal valve (U. S. Nat. Mus. Cat. No. 53674h). Both natural size.

The specimens represented are from Locality **35g**, Eldon limestone on Mount Bosworth, British Columbia. Figure 36A is copied from Walcott [1908d, Pl. VII, fig. 11]; it represents the type specimen.

The specific name was given because of the very thin almost membranaceous shell.

FORMATION AND LOCALITY.—**Middle Cambrian (35g)**: About 4,100 feet (1,250 m.) above the Lower Cambrian and 860 feet (262 m.) below the Upper Cambrian in the shaly limestones in No. 2 of the Eldon limestone, at the north end of the amphitheater northwest of the main ridge of Mount Bosworth, north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide, between British Columbia and Alberta, Canada.

OBOLUS? MENEGHINII Walcott.

Plate XXX, figures 17, 17a.

Not *Lingula petalon* (HICKS MS.) DAVIDSON, 1868, Geol. Mag. vol. 5, p. 308, Pl. XV, fig. 16. (Not taken up in this monograph.)

Not *Lingula petalon* DAVIDSON, 1871, British Fossil Brachiopoda, vol. 3, pt. 7, No. 4, p. 337, Pl. XLIX, fig. 30. (Not taken up in this monograph.)

Lingula petalon BORNEMANN [not DAVIDSON], 1891, Nova Acta Acad. Cæs. Leop.-Carol. Germanicæ Naturæ Curiosornm, Bd. 56, No. 3, p. 438, Pl. XIX (XXXIV), figs. 12–14. (Described in German; see below for translation. Fig. 14a is copied in this monograph, Pl. XXX, fig. 17.)

Obolella sp. (?) BORNEMANN, 1891, idem, p. 440, Pl. XIX (XXXIV), fig. 18. (Characterized in German. Fig. 18 is copied in this monograph, Pl. XXX, fig. 17a.)

Obolus (?) *meneghini* WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 684. (Bornemann's description, 1891, p. 438, translated, and species discussed as below as a new species.)

Bornemann says [1891, p. 438]:

Rounded triangular, frontal margin at times almost straight. Shells rather flat, their arching being greatest in the middle. Concentric and rather coarse lines of growth. Size, 5–11 mm.

The specimen referred to "*Obolella* sp. (?)" by Bornemann [1891, p. 440] is from the slate of Porto Canal Grande. It is not an *Obolella* and may be identical with the species from the sandstones.

The shells referred to "*Lingula petalon*" [Bornemann, 1891, p. 438] suggest *Obolus* in form and surface ornamentation and are tentatively referred to that genus and a specific name given them in recognition of the work of Prof. Giuseppe Meneghini.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**354c**) *Yellow, friable sandstone at Punta Pintau (Canal Grande);* (**354d**) yellow friable sandstone at Gruguetta; and (**354e**) slate at Porto Canal Grande; all [Bornemann, 1891, pp. 438 and 440] in the island of Sardinia, Italy.

OBOLUS MICKWITZI Walcott.

Plate X, figures 1, 1a–k.

Obolus mickwitzi WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 386–387. (Described and discussed as below as a new species.)

General form rounded ovate, with the ventral valve broadly subacuminate, and the dorsal valve obtusely rounded; valves, as shown by the casts, moderately convex, which would give a rather strongly convex shell, as fragments show that it was quite thick over the central portions. Fragments of the shell showing the outer surface indicate that it was marked by concentric lines and striæ of growth; radiating striæ may have been present; they are strongly developed when the outer surface is exfoliated. The casts of a number of examples of the

interior of the valves show very strong concentric undulations and lines of growth, although in some specimens these characters are scarcely perceptible. The fragments of the shell preserved show that it was formed of a thin outer layer, several inner layers or lamellæ of varying thickness, and numerous lamellæ over the anterior and lateral portions of the shell that are slightly oblique to the outer surface. A somewhat rounded ventral valve has a length of 9 mm., width 9 mm.; a dorsal valve 9 mm. long has a width of 8 mm.; a more elongate ventral valve is 9 mm. in length and 8 mm. in width; an associated dorsal valve 7.5 mm. in length has a width of 7 mm.

Casts of the interior of the ventral valve show an area of medium length, divided midway by the cast of a strong, rather broad pedicle furrow, and again a short distance each side of the pedicle furrow by a narrow, sharp, flexure line; striæ of growth cross the area of the pedicle furrow parallel with the front margin. There is slight evidence in one of the casts that the area formed a shelf between the pedicle groove and the lateral margin. The area of the dorsal valve is of medium length and fairly well extended out onto the cardinal slopes (Pl. X, fig. 1d). The cast of the visceral cavity of the ventral valve is well shown by several specimens (Pl. X, figs. 1a, 1b, and 1c). It resembles that of *Obolus matinalis* (Hall) and *O. apollinis quenstedti* (Mickwitz) in the extension of the anterior margins almost directly outward from the center toward the impression of the main vascular sinuses; one of the peculiarities of the species is the great development of the area within the parietal scar (splanchnocœle); in some examples (Pl. X, figs. 1a and 1b) it occupies all the central portions of the shell, extending to within a short distance of the frontal margin. In others it is limited to the posterior half of the shell; the same features occur in the dorsal valve (Pl. X, figs. 1d, 1e, and 1f). There are no traces of a median septum in the ventral valve; in the dorsal valve it is shown in the cast as a very narrow depression between and a little forward of the central muscle scars.

In the ventral valve the anterior lateral muscle scars are distinctly shown, also the trapezoidal area, in which the central, middle lateral, and outside lateral scars occur. In the dorsal valve (Pl. X, figs. 1d and 1g) large central (h) and small anterior lateral (j) scars are clearly defined, also the transmedian (i) scars. Of the markings left on the interior of the shell by the vascular system, the trunk sinuses are usually strongly defined in the smaller shells, extending nearly to the anterior margin, and in the larger shells about three-fourths of the way over the area to the frontal margin.

Owing to the condition of the casts of the interior, the parietal scar is usually not well defined; in the ventral valve it appears to extend from where it arches forward at the center, almost directly outward to the trunk sinuses, where it curves backward across the sinus and outside of the anterior lateral muscle scars; in the dorsal valve it extends from over the median line in front outward and backward around the side of the large central muscle scar, where it curves outward across the trunk sinuses.

Observations.—Attention has been called to the relatively large size of the visceral cavity (splanchnocœle) in both valves of the smaller shells. The range of variation in this respect is so great that it might be accepted as indicating a distinct species if there were not shells intermediate in size in which the splanchnocœle is also intermediate in proportional size. Another marked character in the specimens is the very strong impressions in the cast of the trunk sinuses and muscle scars and visceral markings. This species is somewhat more rounded in outline than *O. mæra* (Hall and Whitfield) and *O. matinalis* (Hall), and it is very distinctly marked by the muscle scars of the dorsal valve.

The specific name was given in honor of Dr. A. Mickwitz.

Formation and locality.—**Upper Cambrian**: (**79, 79′**, and **79b**)[a] "St. Croix sandstone," near Hudson; and (**328j**) "St. Croix sandstone" on Willow River, near Hudson; both in St. Croix County, Wisconsin.

Obolus minimus Walcott.

Plate XI, figures 8, 8a.

Obolus minimus Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 325–326. (Described as below as a new species.)

This is a small shell of the general form of *Obolus shansiensis* Walcott. The ventral valve is obtusely acuminate and the dorsal nearly circular; valves gently convex. Surface marked by

[a] **79** is the type locality.

rather strong concentric lines of growth and numerous very fine concentric striæ. The inner layers of shell are shiny black and ornamented with numerous fine, radiating striæ and concentric lines. Shell built up of several thin layers or lamellæ that form a thin shell over the umbonal region that gradually thickens as the short, oblique lamellæ become more numerous toward the front and side margins. The three specimens in the collection average 3 mm. in transverse diameter; the ventral is a little longer than the dorsal valve.

A partly exfoliated ventral valve shows a well-marked visceral area, extending forward about one-third of the length of the shell; also narrow main vascular sinuses starting near the apex and extending obliquely forward well into the valve, about midway between the median line of the valve and the lateral margins. This neat little shell is distinguished by its nearly circular outline, low convexity, and small size.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**C1**) Lower shale member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 40 (part of the 3d list of fossils), and fig. 10 (bed 4), p. 38], 2 miles (3.2 km.) south of Yenchuang, Sintai district, Shantung, China.

OBOLUS? MINOR Barrande.

Plate XV, figure 6

Obolus? minor BARRANDE, 1868, Faune silurienne des environs de Hof, en Bavière, p. 105, fig. 68. (Described in French as a new species. Fig. 68 is copied in this monograph, Pl. XV, fig. 6.)

Obolus? minor BARRANDE, 1868, Neues Jahrb. für Mineralogie for 1868, p. 693, unnumbered plate, fig. 69. (Text and figure copied from preceding reference.)

Of this species the author [1868a, p. 105] remarks:

We know only the impression figured. It differs from *O.? palliatus* Barrande by having a well-marked beak and in being rather more elongate. The surface is ornamented by rather close concentric striæ regularly spaced. Length 7 mm., width 7 mm.

It is not improbable that this represents the ventral valve of *O.? palliatus*, but in the absence of specimens for comparison it is left with the designation given by Barrande.

FORMATION AND LOCALITY.—**Passage beds** between the Upper Cambrian and the Ordovician: (**303c** [Barrande, 1868a, p. 105]) suburbs of Hof, Bavaria, Germany.

OBOLUS? MIRANDUS (Barrande).

Plate XII, figures 4, 4a.

Lingula? miranda BARRANDE, 1879, Système silurien du centre de la Bohême, vol. 5, Pl. CXI, figs. 1: 1–3. (No text reference. Figs. 3A and 1a are copied in this monograph, Pl. XII, figs. 4 and 4a, respectively.)

In form this species is much like that of *Obolus ancillus* (Barrande) (Pl. XII). The traces shown of the interior markings by figure 4a are similar to those of *Obolus feistmanteli* (Barrande) (Pl. XII, fig. 1). The outer surface, as shown on the figure, recalls that of *O.* (*Westonia*) *ella* (Hall and Whitfield) (Pl. XLVII). With only the two illustrations given by Barrande, it is impossible more than provisionally to refer the species to *Obolus*.

FORMATION AND LOCALITY.—**Lower Ordovician**: (**303k** [Barrande, 1879b, pl. CXI]) Étage d1 at Hradischt, Bohemia, Austria-Hungary.

OBOLUS? MURRAYI Billings.

Plate XV, figure 12.

Obolus? murrayi BILLINGS, 1865, Geol. Survey Canada, Paleozoic Fossils, vol. 1, p. 362. (Described as a new species; see below for copy. The type specimen upon which Billings based his description, but which he did not figure, is represented in this monograph, Pl. XV, fig. 12.)

The original description by Billings follows:

The specimen is very nearly circular, broad ovate, width a little greater than the length, uniformly and moderately convex; the shell black and corneous and covered with fine concentric striæ. Length, 7 lines; width, about 8 lines. Of this species only a single valve was found. * * * It belongs probably to the Quebec group.

This appears to be a true *Obolus*, as far as can be determined from the exterior surface of a single specimen. Its large size and strong concentric striæ indicate that Billings's reference to the "Quebec group" (Lower Ordovician) is probably correct.

The specific name was given in honor of Alex. Murray, who discovered the specimen.

FORMATION AND LOCALITY.—**Lower Ordovician**: (**314g** [Billings, 1865b, p. 362]) A loose piece of gray argillaceous limestone at Maiden Arm, Hare Bay, on the east side of the northern point of Newfoundland.

OBOLUS NAMOUNA Walcott.

Plate VIII, figures 2, 2a.

Obolus namouna WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 390. (Discussed as below as a new species.)

This form is closely related to *O. matinalis* (Hall). It differs mainly in the internal character of the dorsal valve (Pl. VIII, fig. 2a). The area, in addition to the narrow area of *O. matinalis*, extends its lines of growth nearly one-fifth the length of the shell. The visceral area is shorter also than in *O. matinalis*, the central and anterior lateral scars being closer together. Owing to the somewhat imperfect character of the ventral valve, no special points of difference with the ventral valve of *O. matinalis* can be determined. It is associated on the same slabs of sandstone with *O. rhea* Walcott.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**98**) *"St. Croix sandstone" near Eau Claire, Eau Claire County, Wisconsin.*

Middle Cambrian: (**84**) "St. Croix sandstone" at Dresbach, opposite the mouth of Black River, Winona County, Minnesota.

OBOLUS NUNDINA Walcott.

Plate XI, figures 4, 4a.

Obolus nundina WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 326. (Characterized and discussed as below as a new species.)

This little shell differs from *Obolus anceps* Walcott, to which it appears to be most nearly related, by its more nearly circular dorsal valve and its strong, concentrically ridged surface. Its surface is formed by elevated, rounded, concentric ridges that are somewhat irregular. Very fine concentric striæ occur both on the ridges and on the interspaces between.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**61**) Limestone in the Dunderberg shale [Walcott, 1908f, p. 184] a little south of the Hamburg mine, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

(**14b**) *Limestone on Cold Creek at north end of gorge opposite the north end of Sponge Mountain, 2 miles (3.2 km.) south of the San Saba County line, in Llano County, Texas.*

Middle Cambrian: (**58**) Shaly limestones in the upper beds of Secret Canyon shale, east side of New York and Secret canyons, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

OBOLUS OBSCURUS Walcott.

Plate XI, figures 9, 9a–d.

Obolus obscurus WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 326. (Described and discussed essentially as in the first two paragraphs below as a new species.)

A large dorsal valve of this species has a length of 9 mm., width 7 mm. The shell is strong and marked on its inner layers by radiating and concentric striæ; the outer surface has numerous fine, elevated, slightly irregular, concentric striæ that, with a strong lens, give it a roughened appearance.

An interior of a dorsal valve shows a well-developed area, the greater portion of which is taken by the broad pedicle groove; a deep umbonal cavity with a narrow median septum and obscure main vascular sinuses on the outer margins of the cavity. Outside the sinuses, on the posterolateral slope, relatively large muscle scars are indicated.

Since the publication of the original description (the greater part of which is copied in the two preceding paragraphs), better specimens referred to this species were received from the Middle Cambrian of Shansi. These illustrate the form and convexity of the ventral valve and show it to be similar to that of *Obolus chinensis* (Walcott). The concentric ridges are more nearly perfect than those on the fragments associated with the specimens from Shantung. The concentric striæ or ridges are elevated, rounded, with sharp depressions between them;

the ridges are little more than elevated striæ at the aperture, becoming gradually coarser over the central and anterior portions of the valve, where there are from five to seven ridges in a distance of 1 mm.; toward the apex there are more than double the number in the same distance.

Obolus obscurus has a larger and more rounded shell than *O. chinensis* and is also distinguished by the strong, concentrically striated surface, which resembles that of *Micromitra* (*Paterina*) *labradorica orientalis* (Walcott), from which it differs in the form of the shell. It differs from *Obolus* (*Acritis*) *antiquissimus* (Eichwald) (Pl. XIII) in having the concentric striæ or ridges more regular and very rarely bifurcating. *Obolus* (*Acritis?*) *rugatus* Walcott (Pl. XIII) has much stronger concentric ridges. The surface of *O. nundina* Walcott (Pl. XI) is marked by irregularly spaced, rounded, concentric ridges, with rounded depressions between them, instead of the V-shaped depressions and regularly spaced ridges of *O. obscurus*. *Obolus obscurus* has a large strong shell of the general type of *Obolus rhea* Walcott (Pl. IX) of the Middle and Upper Cambrian of Wisconsin.

The material upon which this species was based [Walcott, 1905a, p. 326] was more or less fragmentary, and the specific name was chosen because of the obscure relations of the species.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**C63**) *Sandy shale near the base of the Kiulung group* [*Blackwelder, 1907a, p. 37 (3d paragraph), and fig. 8a (bed 32), p. 29*]. *3.5 miles (5.6 km.) southwest of Yenchuang, Sintai district, Shantung;* and (**C75**) limestone near the base of the Kichou formation [Willis and Blackwelder, 1907, p. 143], 4.5 miles (7.2 km.) south of Wutaihien, Shansi; both in China.

OBOLUS? PALLIATUS Barrande.

Plate XV, figure 5.

Obolus? palliatus BARRANDE (in part), 1868, Faune silurienne des environs de Hof, en Bavière, pp. 104–105, fig. 65 (not fig. 64, referred in this monograph to *Obolus? bavaricus*). (Described and discussed in French as a new species. Fig. 65 is copied in this monograph, Pl. XV, fig. 5.)

Obolus? palliatus BARRANDE (in part), 1868, Neues Jahrb. für Mineralogie for 1868, p. 693, unnumbered plate, fig. 65 (not fig. 64, referred in this monograph to *Obolus? bavaricus*). (Text and figures copied from preceding reference.)

This shell is described from the external characters, and on this account was referred provisionally to the genus *Obolus*. The author states that the form is transverse, beak obtuse, and the convexity of the shell as preserved is greatest near the beak. The substance of the shell appears to be like that of the associated *Lingula*. It is ornamented with fine concentric striæ, which tend to group themselves into bands on some specimens. On Barrande's figure radiating striæ are shown, but are not mentioned in the text. Two specimens have a length of 13 mm., with their widths respectively 16 and 18 mm.

FORMATION AND LOCALITY.—**Passage beds** between the Upper Cambrian and the Ordovician: (**303c** [Barrande, 1868a, p. 105]) Suburbs of Hof, Bavaria, Germany.

OBOLUS PANDEMIA Walcott.

Plate IX, figures 3, 3a–d.

Obolus pandemia WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 388. (Characterized as below as a new species.)

The external form of this species is much like that of *O. matinalis* (Hall) (Pl. VIII). It differs mainly in the characters of the interiors of the valves. In the ventral valve the central ridge is elevated so as to be the most pronounced feature. It not only fills up the space usually occupied by the heart-shaped cavity, but rises much above the interior surface of the shell. The trapezoidal areas (c) and the depressions occupied by the main vascular sinuses are seen only with difficulty. The essential characters of the species are shown by figures on Plate IX.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**10a**) Sandy layers of the Rome formation, in west railroad cut through Shooks Gap, in Bays Mountains, 10 miles (16.1 km.) southeast of Knoxville [Keith, 1895, areal geology sheet], Knox County, Tennessee.

Obolus panderi Mickwitz.

Obolus panderi Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 149–151, Pl. II, figs. 13a–d. (Described and discussed in German as a new species.)

According to Mickwitz, two fragments of this species have been found. These fragments indicate that the shell was one of the largest species from the *Obolus* sandstone, being nearly twice as large as the nearly related *O. triangularis* Mickwitz. He separates it from the latter species on account of its size, "the pronounced pentagonal angular central groove, and the remarkable combination of the corneous projection with the ridges of the main vascular canals, and the somewhat less convexity of the ventral valve."

Mickwitz states that this species is very rare. He gives a most detailed account of it, to which the student is referred.

The specific name was given in honor of C. H. Pander.

Formation and locality.—**Upper Cambrian**: (**395** [Mickwitz, 1896, p. 151]) *Obolus* sandstone at Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval, Government of Esthonia, Russia.

Obolus parvus Walcott.

Text figures 37A–B.

Obolus parvus Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 61–62, Pl. VII, figs. 10 and 10a. (Described and discussed as a new species. Figs. 10 and 10a are copied in this monograph as figs. 37A and 37B.)

Shell small, moderately convex, nearly semicircular in outline. Ventral valve a little longer than wide and with the umbo curving gently to the minute marginal beak. Dorsal valve a little wider than long and with apex marginal. Surface marked by minute concentric striæ of growth and an exceedingly fine network of irregular lines that, with a lens magnifying 20 diameters, give it the appearance of the surface of *Lingulella* (*Lingulepis*) *longinervis* (Matthew) (Pl. XLIV, fig. 1p). Nothing is known of the interior of the valves.

A B

Figure 37.—*Obolus parvus* Walcott. A, exterior of a ventral valve, the type specimen (U. S. Nat. Mus. Cat. No. 51400a). B, exterior of a dorsal valve (U. S. Nat. Mus. Cat. No. 51400b).

Figures 37A and 37B are copied from Walcott [1908d, Pl. VII, figs. 10 and 10a]. The specimens are from Locality **35c**, Lower Cambrian shale, on Mount Bosworth, British Columbia.

The average diameter of the valves is from 1.5 to 2 mm., with the ventral valve a little longer than wide and the dorsal valve slightly transverse in outline.

In outline the shell approaches most nearly to *Obolus rotundatus* (Walcott) (Pl. XX, figs. 2, 2a–e) of the Middle and Upper Cambrian. It differs in having a more rounded posterior outline in the ventral valve and in its more transverse dorsal valve. *Obolus pheres* Walcott (Pl. XI, figs. 6, 6a–b) of the Upper Cambrian is a very small shell, but it is thicker and also more elongate than *O. parvus*. In form it resembles *Obolus minimus* Walcott, from China (Pl. XI, figs. 8 and 8a), but it differs in having a less elongate ventral valve and in its peculiar surface.

Formation and locality.—**Lower Cambrian**: (**35c**) *Drift blocks of siliceous shale supposed to have come from the Mount Whyte formation [Walcott, 1908f, p. 214], found on the south slope of Mount Bosworth, about 500 feet (152 m.) northwest of the Canadian Pacific Railway track between Stephen and Hector, eastern British Columbia.*

(**35e**) About 270 feet (82.3 m.) below the Middle Cambrian, in a greenish siliceous shale correlated with No. 3 of the Mount Whyte formation on Mount Bosworth [Walcott, 1908f, p. 214], in the amphitheater between Popes Peak and Mount Whyte, about 3 miles (4.8 km.) northwest of Lake Louise, southwest of Laggan, on the Canadian Pacific Railway; and (**58t**) sandy shale about 150 feet (45.7 m.) below the Middle Cambrian, just below the big cliff on the east shoulder of Castle Mountain, north of the Canadian Pacific Railway; both in Alberta, Canada.

Obolus pheres Walcott.

Plate XI, figures 6, 6a–b.

Obolus pheres Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 328. (Characterized as below as a new species.)

This is one of the smallest of the *Obolus* species known to me, as it does not average 2 mm. in diameter. It recalls at first sight *Lingulella winona convexa* (Walcott); but it differs in having a thick lamellated shell and in being more rounded on the cardinal angles. The exterior

surface is marked by concentric lines of growth. The shell is built up of thin layers or lamellæ, those toward the front and sides being arranged obliquely to the surface, as in all of the thick-shelled species of *Obolus*.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**10v**) Shales in the "St. Croix sandstone," at Fox Glen, about 8 miles (12.8 km.) east of Baraboo, Baraboo quadrangle (U. S. Geol. Survey), Sauk County, Wisconsin.

OBOLUS PRINDLEI (Walcott).

Plate XXVII, figures 3, 3a–e.

Obolus (*Lingulella*) *prindlei* WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 412. (Characterized and discussed essentially as below as a new species.)

This species was at first considered to be identical with *Lingulella granvillensis* Walcott (Pl. XXII). The study of a new lot of well-preserved specimens shows that it differs from *granvillensis* in being less elongate, more ovate in outline, and marked upon the interior by a very finely granulated surface; in the cast the papillæ and the fine depressions between them appear to be arranged in transverse undulating lines. The transverse lines of growth on the area of the ventral valve, as seen in the cast, are peculiar in having an imbricating or lamellose-like arrangement. The areas of both valves are rather large for so small a species. The average length of the ventral valve is 3.5 mm. to 4 mm., and the width is 3.25 mm. The dorsal valve is a little shorter than the ventral.

Obolus prindlei belongs to a group of small shells (Pls. XXIX to XXXI) that is represented by *Lingulella ferruginea* Salter, *Obolus rotundatus* (Walcott), *Lingulella desiderata* (Walcott), *Obolus chinensis* (Walcott), *Lingulella damesi* (Walcott), and *L. granvillensis* Walcott. These forms are among the earliest specimens of the genus and range through to the Ordovician fauna. *Lingulella granvillensis* and *Obolus prindlei* occur in the upper limit of the *Olenellus* fauna of eastern New York and western Vermont, and *Obolus rotundatus* and *Lingulella manticula* (White) are found at the base of the Ordovician fauna.

The specific name is given in recognition of the effective work of Mr. L. M. Prindle, who, as assistant to Prof. T. Nelson Dale, collected the first specimens of the species.

FORMATION AND LOCALITY.—**Lower Cambrian**: (**29**) Limestone just above the bridge at the Stockport paper mill on Kinderhook Creek, Columbia County; (**35**) limestones 1.5 miles (2.4 km.) north of Bald Mountain and 3.5 miles (5.6 km.) north-northwest of Greenwich, Schuylerville quadrangle (U. S. Geol. Survey), Washington County; (**45b**) limestone near the roadside about 1,200 feet (366 m.) east of Bristol's house, near Low Hampton, about 5 miles (8 km.) east-northeast of Whitehall, Whitehall quadrangle (U. S. Geol. Survey), Washington County; (**36b**) limestones near schoolhouse No. 12, near Greenwich, Cambridge quadrangle (U. S. Geol. Survey), Washington County; (**38a**) limestone 2 miles (3.2 km.) south of North Granville, on the road which turns south from the road running between that village and Truthville, 4 miles (6.4 km.) west-northwest of Granville, Fort Ann quadrangle (U. S. Geol. Survey), Washington County; (**72**) limestone 5 miles (8 km.) east of Albany, Rensselaer County; (**2b**) limestone just north of Beman Park, in the northeastern part of the city of Troy, Rensselaer County; (**338k**) limestone 2.5 miles (4 km.) southwest of Wynantskill, Rensselaer County; and (**72a**) *limestone 1 mile (1.6 km.) southwest of Wynantskill, Rensselaer County;* all in New York.

Specimens that are compared with *Obolus prindlei* occur at the following locality:

Lower Cambrian: (**25a**) Limestone on the Hall (Donaldson's) farm, 2 miles (3.2 km.) east of Swanton, Franklin County, Vermont.

OBOLUS REFULGENS Matthew.

Plate IX, figures 2, 2a–d.

Obolus refulgens MATTHEW, 1892, Trans. Roy. Soc. Canada, vol. 9, sec. 4, No. 5, pp. 44–45, Pl. XII, figs. 6a–d. (Described and discussed as a new species. The specimens represented by figs. 6d (ventral) and 6d (dorsal) are redrawn in this monograph, Pl. IX, figs. 2 and 2a, respectively.)

Obolus ? refulgens MICKWITZ, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 23–24. (Discussed in German.)

Obolus refulgens MATTHEW, 1902, Trans. Roy. Soc. Canada, 2d ser., vol. 8, sec. 4, No. 3, p. 96, plate opposite p. 112, figs. 11a–b. (Discussed.)

Obolus (*Monobolina*) *refulgens* MATTHEW, 1902, idem, p. 98. (Changes generic reference.)

Monobolina refulgens MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 210–213, Pl. XVI, figs. 2a–b, Pl. XI, figs. 4a–b. (Copies the original description, Matthew, 1892, pp. 44–45, and describes and discusses species. Pl. XI, figs. 4a–b, are copied from Matthew, 1892, Pl. XII, figs. 6d (ventral) and 6d (dorsal); Pl. XVI, figs. 2a–b, are copied from Matthew, 1902b, plate opposite p. 112, figs. 11a–b.)

General form transversely ovate, the dorsal valve being slightly more rounded at the beak than the ventral. Valves rather strongly convex, as seen in a single specimen of an uncompressed dorsal valve; most of the shells are flattened in the shale. Surface of shell marked by concentric lines of growth and very fine, irregular striæ that inosculate so as to produce a surface much resembling that of *Obolus fragilis* (Walcott), *Lingulella bellula* (Walcott), *Obolus* (*Westonia*) *ella* (Hall and Whitfield), and other forms. The shell is not preserved on any of the specimens in the collection. A ventral valve 6.25 millimeters in length has a width of 6.5 millimeters; a larger dorsal valve 8 mm. in length has a width of 9 mm.

The cast of the interior of the valves shows a clearly defined rather strong area on each valve. The only muscle scars clearly defined are the central scars of the dorsal valve.

Observations.—This species has the general form of *Obolus mickwitzi* Walcott (Pl. X) but in the absence of good specimens detailed comparisons are of little value.

Matthew [1902b, p. 98] includes *Obolus refulgens* in the subgenus *Monobolina* Salter [1866b, p. 334] on account of the close approximation of the "anterior adductor scars" of the dorsal valve.

The illustrations by Davidson [1866, Pl. IV, figs. 20–27] of *Monobolina plumbea* (Salter) indicate a platform of the type of that found in *Elkania* (Pl. LI, figs. 1, 1a, and 4b), and as *Monobolina plumbea* is a Lower Ordovician species it may be that the latter is a descendant of *Elkania* of the Cambrian. It is certainly not an *Obolus*.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**308** [*Matthew, 1892, p. 45*]) *Shales of Division C3c of Matthew* [*1892, p. 43*], *at Navy Island, St. John Harbor, New Brunswick.*

(**307** [Matthew, 1903, p. 213]) Shales of Division C3c of Matthew [1901a, p. 276], on McLeod Brook (=Barachois River); and (**372e** [Matthew, 1903, p. 50]) shales on McMullins Brook, near McLeod Brook; both in Cape Breton, Nova Scotia.

OBOLUS RHEA Walcott.

Plate IX, figures 1, 1a–c.

Obolus rhea WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 387–388. (Described and discussed as below as a new species.)

General form elongate ovate, with the ventral valve subacuminate, and the dorsal valve elongate ovate in outline. Outer surface unknown, as all of the shells referred to this species are more or less exfoliated; the surface of the inner layers shows numerous, rather broad, radiating striæ, and concentric lines of growth. The shell appears to have been formed of a thin outer layer and several inner layers or lamellæ arranged in the same manner as in *Obolus matinalis* (Hall). A ventral valve 8 mm. in length has a width of 6 mm.; a shorter, broader valve is 6.5 mm. long and 5.5 mm. wide. The two dorsal valves referred to this species are larger than the ventral valves; one 9.25 mm. long has a width of 6.75 mm. and another 9.25 mm. long has a width of 7.25 mm.

Casts of the interior of the ventral valve show a rather short area that is not clearly defined in any of the specimens. The cast of the pedicle groove is narrow and merges into the cast of the groove extending forward to the visceral area; the area is also marked by flexure lines and transverse striæ of growth. The area of the dorsal valve is short in the one specimen showing it. The cast of the visceral cavity on a ventral valve is clearly defined by a rather narrow ridge that is expanded anteriorly in what may represent the heart-shaped cavity (v) (Pl. IX, figs. 1, 1a). The parietal scar passes around in front of the visceral cavity and then a little backward to the main vascular sinuses. No traces of a median septum have been seen in either valve.

The only traces of muscle scars observed are some irregular markings in the trapezoidal area (c), in which the central, middle lateral, and outside lateral scars occur in the ventral valve.

Observations.—This somewhat peculiar species is associated with *Obolus namouna* Walcott, *Dicellomus politus* (Hall), and *Obolus matinalis* (Hall). The dorsal valves are clearly distinct from any described form, approaching in some respects the elongate dorsal valve of *Lingulella* (*Lingulepis*) *acuminata* (Conrad) (Pls. XL to XLII), differing, however, in being narrow and more elongate; the ventral valves appear to be broader in proportion than the dorsal valve and approach *O. matinalis* (Hall) (Pl. VIII) in outline but are more elongate.

Formation and locality.—**Upper Cambrian:** (**98**) *"St. Croix sandstone" at Eau Claire, Eau Claire County, Wisconsin.*

Middle Cambrian: (**84**) "St. Croix sandstone" at Dresbach, opposite the mouth of Black River, Winona County, Minnesota.

Obolus? rokitzanensis Barrande.

Plate XII, figure 6.

Obolus? rokitzanensis Barrande, 1879, Systême silurien du centre de la Bohême, vol. 5, Pl. CXXVI, fig. II: 5. (No text reference. Fig. 5A is copied in this monograph, Pl. XII, fig. 6.)

Barrande gives only one illustration of this species. It recalls to mind those forms of *Obolus* which preserve the radial striation on the interior surface. The configuration of the visceral area also suggests that of the ventral valve of *Obolus*. The illustration is introduced in order that the student may have before him a representation of all of the *Obolus*-like shells known to me. Figure 5 of Barrande [1879b, Pl. CXXVI] should be compared with the ventral valve of *Obolus complexus* Barrande (Pl. XII, fig. 3, of this monograph), and for the radial striation with Plate XII, figure 3b.

The specific name is derived from Rokitzan, the type locality.

Formation and locality.—**Lower Ordovician:** (**303b** [Barrande, 1879b, Pl. CXXVI]) Étage d1 in the environs of Rokitzan, Bohemia, Austria-Hungary.

Obolus rotundatus (Walcott).

Plate XX, figures 2, 2a–e.

Obolus (*Lingulella*) *rotundatus* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 415. (Characterized as a new species; see first paragraph below for copy.)

Obolus (*Lingulella*) *desideratus* Walcott, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, pp. 445–446, Pl. LX, fig. 2a (not fig. 2, referred to *Lingulella desiderata*). (Described and discussed. The specimen represented by figure 2a is redrawn in this monograph, Pl. XX, fig. 2e.)

This small species is associated with *Lingulella manticula* (White). It differs from it in its nearly circular form and more strongly pitted or punctate interior of the valves. A cast of the interior of a dorsal valve shows a well-defined area, the cast of the median ridge and septum, and the central muscle scars. The ventral valve has a length of 3.5 mm., width 3 mm.; dorsal valve, length 3 mm., width 3 mm.

The shells represented by Plate XX, figures 2 and 2a, are associated in the same hand specimens of limestone with *Lingulella manticula*. The specimens represented by Plate XX, figures 2b, 2c, and 2d, are from the Upper Cambrian beds of the Gallatin Valley, Montana, but so far as can be determined from the material at hand for comparison they appear to represent the same species.

Formation and locality.—**Lower Ordovician:** (**313d**) *Limestone at Schellbourne, Schell Creek Range, White Pine County, Nevada.*

Upper Cambrian: (**160a**) Sandstone west of Bear Creek, south of the Gallatin Valley, southwest of Bozeman, Threeforks quadrangle (U. S. Geol. Survey), Gallatin County, Montana.

(**30q**) Limestones about 2,300 feet (701 m.) above the Cambrian quartzites, on pipe line above limekiln, in Ogden Canyon, 1 mile (1.6 km.) above its mouth, east of Ogden, Weber County; (**34i**) shales about 1 mile (1.6 km.) northeast of Sand Pass, at the south end of the Fish Spring Range, Juab County; (**33d**) thin-bedded blue limestone at the base of the first high point southwest of the J. J. Thomas ranch, on the east side of the Fish Spring Range, Juab County; (**30y**) about 1,400 feet (426.7 m.) above the Middle Cambrian and 1,900 feet (579.1 m.) below the top of the Upper Cambrian in the supposed metamorphosed equivalent of the shales forming 1b of the Orr formation [Walcott, 1908f, p. 176], above the granite contact on top of the ridge north of Notch Peak [Walcott, 1908f, Pls. XIII and XIV], House Range, Millard County; and (**34r**) limestones 1.5 miles (2.4 km.) northwest of Wahwah Spring, about halfway up the section to the north of the road at Cane Pass, Wahwah Mountains, Beaver County; all in Utah.

(8o) Limestone on the slope of the ridge where the range swings around to the northwest, 2 miles (3.2 km.) north of Aurum, Schell Creek Range, White Pine County, Nevada.

(96) Limestone near the ford on the Cedartown road, 1.5 miles (2.4 km.) south of Rome, Floyd County, Georgia.

Middle Cambrian: (159) Limestones north of West Gallatin (Gallatin) River, Gallatin County, Montana.

(302b) Limestones near Crowfoot Ridge, Gallatin quadrangle (U. S. Geol. Survey), Yellowstone National Park, Wyoming.

(34n) Shales about 100 feet (30.5 m.) above the Tintic quartzite [G. O. Smith, 1900, p. 1] near the summit of the ridge between Mammoth and Eureka, Tintic special quadrangle (U. S. Geol. Survey), Juab County, Utah.

(11o) About 2,750 feet (838.2 m.) above the Lower Cambrian and 1,650 feet (502.9 m.) below the Upper Cambrian, at the base of the limestone forming 1a of the Marjum limestone [Walcott, 1908f, p. 179], about 4 miles (6.4 km.) southeast of Antelope Springs in the spur at the junction of the Deseret and Swasey Spring roads [Walcott, 1908f, Pl. XIII], House Range, Millard County; (11x) about 2,200 feet (670.6 m.) above the Lower Cambrian and 2,200 feet (670.6 m.) below the Upper Cambrian in the limestones forming 1d of the Marjum limestone [Walcott, 1908f, p. 180], 2.5 miles (4 km.) east of Antelope Springs, in ridge east of Wheeler Amphitheater [Walcott, 1908f, Pls. XIII and XV], House Range, Millard County; all in Utah.

(7i) Limestone just west of the summit on the road east of Schellhourne, Schell Creek Range, White Pine County; and (7j) limestones at the north end of the Quinn Canyon Range, 1 mile (1.6 km.) northwest of Italian Ranch foothills, Nye County; both in Nevada.

Specimens that are somewhat doubtfully referred to this species occur at the following locality:

Upper Cambrian: (8p) Limestone halfway up the canyon east of McGill's ranch, on the west side of the Schell Creek Range, 14 miles (22.5 km.) northeast of Ely, White Pine County, Nevada.

Obolus schmalenseei (Walcott).

Plate XXX, figures 19, 19a–e.

Obolus (Lingulella) schmalensei Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 605. (Characterized as below as a new species.)

This is the European representative of the American *Obolus rotundatus* (Walcott) (Pl. XX). Its outline is slightly elongate to subcircular. When the shell is exfoliated, the cast indicates that it was strong over the visceral area and thin toward the margins. The characteristic features are well shown in the drawings.

The specific name is given in honor of Mr. Schmalensee, who collected the material for me.

Formation and locality.—**Middle Cambrian:** (8w) *Limestones of Paradoxides forchhammeri zone, at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad, Sweden.*

(16h) Limestones of the *Paradoxides forchhammeri* zone, at Borregaard; and (16i) limestones of the *Conocoryphe exsulans* zone, at Borregaard; both on Bornholm Island, Denmark.

Obolus schmidti Mickwitz.

Plate XV, figures 11a–c.

Obolus schmidti Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 152–154, Pl. II, figs. 14a–c. (Described and discussed in German as a new species; see below for translation of the diagnosis. Figs. 14a–c are copied in this monograph, Pl. XV, figs. 11a–c, respectively.)

The original description by Mickwitz follows:

Shells large, moderately arched; outline broad, egg-shaped; posterior borders of shell convex, not winged; beak of the large shell scarcely prolonged. Surface of shell faintly polished. Growth lamellæ marked by deep, regular, roughly cut concentric furrows. Concentric striæ fine, irregular, mingled. Radial striæ perceptible as indistinct traces. Area of large shell very small, peduncular groove pit-shaped. Thickening of posterior part of shell falling away in two terraces to middle of shell. First terrace is steep at the broadest place of the heart-shaped groove, the second flat in front of the point of the latter. Posterior part of the thickening in the form of two club-shaped swellings, which, separated at their posterior thick parts by a deep furrow in the prolongation of the peduncular groove, pass over with their anterior ends into the swellings of the principal vessel furrows. Splanchnocœle of the large shell strikingly shortened. Secondary, inwardly diverging traces of the vessels rectilinear, not ramified.

Observations.—Mickwitz states that, in addition to the concentric striæ described and very faint traces of radial striæ, there are over the entire rather rough surface of the shell scattered, irregular, flat grooves, whose radial position is unmistakable. He also calls attention to the

peculiar interior configuration as described and shown in the illustrations. This species is stated to be very rare and restricted to the *Obolus* sandstone.

The specific name was given in honor of Dr. Fr. Schmidt.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**395** [Mickwitz, 1896, p. 153]) *Obolus* sandstone at Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval, Government of Esthonia, Russia.

OBOLUS SELWYNI (Matthew).

Plate XXXVI, figures 1, 1a–h, 2, 2a–b; Plate XXXVII, figures 1, 1a–f.

Lingulella selwyni MATTHEW, 1895, Trans. Roy. Soc. Canada for 1895, 2d ser., vol. 1, sec. 4, No. 13, pp. 255–256, Pl. I, figs. 1a–b. (Described and discussed as a new species. The specimen represented by fig. 1b is redrawn in this monograph, Pl. XXXVII, fig. 1c.)

Obolus æquiputeis MATTHEW, 1902, idem, 2d ser., vol. 8, sec. 4, No. 3, p. 94, Pl. I, figs. 4a–e. (Characterized. The specimens represented by figures 4b and 4d are redrawn in this monograph, Pl. XXXVI, figs. 2 and 2a, respectively.)

Lingulella selwyni MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 62–63. (Notes on orientation of shells.)

Lingulella selwyni MATTHEW, 1903, idem, pp. 116–123, figures on p. 117, and Pl. VII, figs. 1a–c. (Described and discussed. The original reference, Matthew, 1895, pp. 255–256, is copied on pp. 120 and 121. The figures given on p. 117 are diagrammatic drawings based on the specimens figured by Matthew, 1895, Pl. I, figs. 1a and 1b. Matthew's original drawings are, however, also copied in this reference, Matthew, 1903, Pl. VII, figs. 1a and 1b. Pl. XXXVII, fig. 1c, of this monograph represents the specimen upon which Matthew based the diagrammatic figures given in the right-hand figure on p. 117 and that given in Pl. VII, fig. 1b. Pl. XXXVI, figs. 1 and 1c, of this monograph represent the specimens on which Matthew based the diagrammatic figures given in the left-hand figure on p. 117 and that given in Pl. VII, figs. 1a and 1c.)

Obolus æquiputeis MATTHEW, 1903, idem, p. 139, Pl. VIII, figs. 2a–e. (Described as a new species, but it is not the first reference to the species; see above. The marginal reference gives the species as *Obolus* (*Eoobolus*) *æquiputeis*. Figs. 2a–e are copied from Matthew, 1902, Pl. I, figs. 4a–e.)

General form subovate, broadly rounded in front. Ventral valve subacuminate and dorsal valve broadly rounded at the beak. Surface of the shell marked by very fine, concentric striæ and lines of growth and indistinct very narrow undulations of the shell radiating from the beak. When the thin exterior shell is exfoliated fine radiating lines are seen, and the inner surface (outside of the visceral areas) shows radiating lines toward the anterior margin and irregularly distributed punctæ. The shell is of rather more than medium thickness. It is built up of a thin outer layer and several inner layers, very much as the shell of *Lingulella acutangula* (Roemer) (Pl. XVII, figs. 1m, 1n, and 1o).

A large, slightly distorted ventral valve has a length of 14 mm.; width, 11 mm. The original proportion of length and width of this specimen was probably 14 to 12. The dorsal valve was probably of equal length and width.

The area of the ventral valve is more or less distorted in all the specimens; its character is best shown in Plate XXXVII, figure 1b; and the area of the dorsal valve in Plate XXXVII, figure 1e. The pedicle furrow is strong and well defined (Pl. XXXVII, fig. 1b).

The cast of the interior of the ventral valve shows the visceral cavity and the heart-shaped pit (x) (Pl. XXXVII, fig. 1d) so characteristic of *Obolus*. There are no traces of a median septum in the ventral valve; in the dorsal valve it is a sharp, narrow ridge (Pl. XXXVI, figs. 1e–g).

The muscle scars of the valves are well shown in casts of the interior. The umbonal scar of the dorsal valve is elongate (Pl. XXXVII, figs. 1c and 1f, and Pl. XXXVI, fig. 1e). I have not observed it in the ventral valve. The scars of the central muscles (h) are distinct in the dorsal valve (Pl. XXXVII, fig. 1c), but on the ventral valve they are merged with the middle laterals in the trapezoidal area (c) (fig. 1d). The outside laterals (l) are preserved in interiors of the ventral valve (Pl. XXXVI, figs. 1d and 1e) and the dorsal valve (Pl. XXXVI, fig. 1e). The middle laterals (k) are shown on the dorsal valve (Pl. XXXVI, fig. 1e), but have not been seen on the ventral valve. The anterior laterals are shown for the dorsal valve at (j) (fig. 1c). The transmedian scars (i) are preserved on casts of the dorsal valve (Pl. XXXVII, figs. 1c, 1e, and 1f) and the ventral valve (Pl. XXXVI, fig. 1a).

The parietal scar is clearly shown in front of the visceral cavity of the ventral valve, between the main vascular sinuses (ps) (Pl. XXXVII, fig. 1d), but it has not been traced beyond the main sinus. On the dorsal valve its course may be followed from the median line in front of the anterior lateral muscle scars (j), back beyond the central scars (h), to a point where it curves outward (ps) (Pl. XXXVII, fig. 1c).

Observations.—Matthew sent me the types of this species for study and illustration. From the first lot sent in 1900 the figures on Plate XXXVII were made. A second lot sent in 1903 gave the fine illustrations on Plate XXXVI. The two figures in his paper (1895b, Pl. I) of the ventral and dorsal valve are essentially diagrammatic, combining as they do the characters seen in a number of specimens. I have illustrated several of the specimens that appear to me to give a fair presentation of the characters.

As stated by Matthew [1895b, p. 256] the plan of the muscular scars of this species is very nearly that of *Obolus apollinis quenstedti* (Mickwitz). It may also be compared with the arrangement of the scars of *Lingulella acutangula* (Roemer). Further reference to *O. selwyni* will be found under the discussion of *Obolus* and *Lingulella* (p. 377). In a general way comparison may be made between *Obolus selwyni* and *Lingulella acutangula;* specifically there are strong variations between them.

Obolus æquiputeis Matthew appears to be in all respects identical with *O. selwyni.* To illustrate the identity of the two species photographs were made of the types of *O. æquiputeis* (Pl. XXXVI, figs. 2, 2a–b). The dorsal interiors have both been distorted. In figure 2b the distortion is from transverse compression; in figure 2c from longitudinal compression. The specimen represented by the latter is associated with *Obolus selwyni.* The specimens represented by Plate XXXVI, figures 2a and 2b, are casts in a matrix that preserves the interiors very clearly. Plate XXXVI, figure 2c, and all other illustrated specimens of this species, are from a matrix in which the shell is compressed so as to obscure the interior markings.

The calcareous sandstones in which this species occurs were referred to the Ordovician by Matthew [1895b, p. 255], but in his review of the Cape Breton Cambrian faunas [1903, p. 123] he assigns it to Division E2a? of his lower Etcheminian.

The specific name was given in honor of Dr. A. R. C. Selwyn.

Formation and locality.—**Middle Cambrian:** (**307d** [Matthew, 1903, p. 123]) Sandy limestone of Division E2a? of Matthew's [1903, p. 19] Etcheminian, on Young (McFees) Point near George River Station, on the Intercolonial Railway, eastern Cape Breton, Nova Scotia.

Obolus septalis (Walcott).

Plate XXIII, figure 3d; Plate XXXIV, figures 2, 2a.

Obolus (Lingulella) septalis Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 331. (Characterized as below as a new species.)

Obolus mcconnelli Walcott (in part), 1908, Canadian Alpine Journal, vol. 1, No. 2, p. 244, Pl. I, fig. 2a (not fig. 2, which represents a specimen of *Obolus mcconnelli*). (No text reference. Fig. 2a is copied in this monograph, Pl. XXIII, fig. 3d.)

The dorsal valve is all that is known of this little shell. There are two specimens in the collections of the United States National Museum and three in the collection of Bryon E. Walker, of Toronto, Canada.

The general form of the valves is much like that of *Obolus rotundatus* (Walcott) (Pl. XX). It is distinguished from the latter and other described species by the strong median ridge and septum of the dorsal valve. The outer surface is marked by concentric striæ and lines of growth and very fine irregular concentric striæ that give a minutely rough surface.

This form owes its specific name to the presence of a septum in the dorsal valve.

Formation and locality.—**Middle Cambrian:** (**14s**) About 2,300 feet (701 m.) above the Lower Cambrian and 2,700 feet (823 m.) below the Upper Cambrian in the *Ogygopsis* zone of the Stephen formation [Walcott, 1908f, p. 210], at the "fossil bed" on the northwest slope of Mount Stephen, above Field on the Canadian Pacific Railway, British Columbia, Canada.

Obolus shansiensis Walcott.

Plate XI, figures 7, 7a–c.

Obolus shensiensis Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 327. (Described and discussed as below as a new species, the spelling *shensiensis* being in error because the type specimens came from a locality in the Province of Shansi, not Shensi, although the species occurs in that province.)

General form ovate, with the ventral valve broadly subacuminate and dorsal valve obtusely rounded. Valves moderately convex in the specimens embedded in a fine-grained, dark limestone. Surface marked by fine, sharp, concentric striæ and traces of irregular, obscurely defined, low, radiating ridges; the interior layers show fine radiating striæ and concentric lines; the shell is strong and built up of numerous lamellæ oblique to the outer surface. The largest ventral valve has a length of 9 mm., width 7 mm. Nothing is known of the interior of the valves.

The form, surface markings, and shell structure are much like those of *Obolus matinalis* (Hall) (Pl. VIII) and *O. tetonensis* Walcott (Pl. IX). In outline *O. shansiensis* is more elongate than *O. matinalis* and less so than *O. tetonensis*.

This form owes its specific name to the occurrence of the type specimen in the Province of Shansi, China.

Formation and locality.—**Middle Cambrian**: (**C37**) *Upper part of the Kichou limestone in dense black limestone nodules in green-gray shales 10 feet below the base of the cliff limestone* [*Willis and Blackwelder, 1907, p. 146*], *8 miles (12.8 km.) south of Tinghianghien, Shansi;* (**C32**) A fine-grained bluish-black limestone bowlder believed to have come from the lower part of the Kisinling limestone [Blackwelder, 1907b, p. 272], collected in river drift 1 mile (1.6 km.) south of Chonpinghien, on Nankiang River, southern Shensi; and (**C71**)[a] massive cliff-forming limestone in the central portion of the Kichou formation [Willis and Blackwelder, 1907, pp. 139 and 145 (2d list of fossils)], 4 miles (6.4 km.) southwest of Tungyu, Shansi; all in China.

Obolus sinoe (Walcott).

Plate XXVI, figures 2, 2a–h.

Obolus (*Lingulella*) *sinoe* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 416–417. (Described and discussed as below as a new species.)

General form broad ovate, with the ventral valve broadly subacuminate and the dorsal valve broadly ovate. Valves moderately convex, as far as can be determined from the series of shells preserved in the fine-grained sandstone. A ventral valve 5 mm. in length has a width of 4.25 mm. A dorsal valve 4 mm. in length has an equal width.

The traces remaining of the exterior shell show it to have been marked by concentric lines and striæ of growth; when the outer layer is exfoliated radiating striæ cross the lamellæ; a fragment of the inner surface of the shell indicates that there were scattered pits or punctæ and fine radiating striæ; the shell was relatively thick and formed of a thin outer layer and several inner layers or lamellæ, the lamellæ of the anterior portion of the shell being arranged in layers slightly oblique to the outer surface of the shell.

Casts of the interior of the ventral valve show a well-defined area marked by strong flexure lines that occur midway between the lateral margins and the narrow, well-defined pedicle groove; striæ of growth cross the area parallel with its base. The area of the dorsal valve is relatively short and does not extend very far out on the cardinal slopes. The interior markings of the ventral and dorsal valves show imperfectly the main vascular sinuses and visceral area, the central and anterior lateral muscle scars, and a narrow median ridge.

Observations.—This species occurs at the same relative stratigraphic horizon as *Lingulella ino* (Walcott) (Pl. XXVI) and is about the same size. It differs, however, in its more circular form, which is persistent in a large number of shells. In form it more nearly resembles *Obolus rotundatus* (Walcott) (Pl. XX) of the Upper Cambrian. It differs from that in being uniformly

[a] This species is somewhat doubtfully identified from this locality.

larger and in having a thicker, stronger shell. Some of the shells in the limestone look very much like *Dicellomus politus* (Hall) (Pl. LII) when they are not compressed.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**327**) Arenaceous limestone east of Gold Camp, Caballos Mountains, New Mexico.

(**302d**) Limestone 200 yards (183 m.) north of the southwest corner of sec. 18, T. 28 N., R. 113 W., Uinta County, Wyoming.

(**14b**) Limestone on Cold Creek at north end of gorge opposite the north end of Sponge Mountain, 2 miles (3.2 km.) south of the San Saba County line, in Llano County; (**14e**) limestone in Bartlett Hollow, 2 miles (3.2 km.) southeast of the mouth of Falls Creek, Burnet quadrangle (U. S. Geol. Survey), Lampasas County; (**67**) sandstone on Tatur Hill, 7 miles (11.2 km.) northwest of Burnet, Burnet County; (**69**) limestone near Honey Creek, Burnet County; (**71**) limestone in Cold Creek Canyon, Burnet County; (**68y**) interbedded sandstone and limestone, Packsaddle Mountain, Llano County; and (**70**) *limestone near Morgans Creek, Burnet County;* all in Texas.

Middle Cambrian: (**302x**) Sandstones near the head of Powder River, Bighorn Mountains, Wyoming.

(**11j**) Basal part of Bonneterre limestone, Mine Lamotte, Madison County, Missouri.

(**11a**) Sandstone between First and Armstrong creeks, in the southeast corner of the Maynardville quadrangle (U. S. Geol. Survey), Union County, Tennessee.

(**92x**) Conasauga ("Coosa") shale at Yanceys Bend, Coosa River, southeast of Center, Cherokee County, Alabama.

OBOLUS SMITHI Walcott.

Text figures 38A–C.

Obolus smithi WALCOTT (in part), 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 62–63, Pl. VII, fig. 9a (not fig. 9, which represents a specimen of *Micromitra* (*Paterina*) *major*).[a] (Described and discussed as below as a new species. Fig. 9a is copied in this monograph as fig. 38B.)

General form broadly ovate, with the ventral valve obtusely acuminate and the dorsal valve subcircular, slightly transverse; convexity apparently moderate, judging from the specimens as they occur slightly flattened out in the calcareous shales. The shell was relatively strong and formed of a number of thin layers or lamellæ that, toward the outer edge of the valve, were more numerous and gave a scaly appearance to the margins of the old shells.

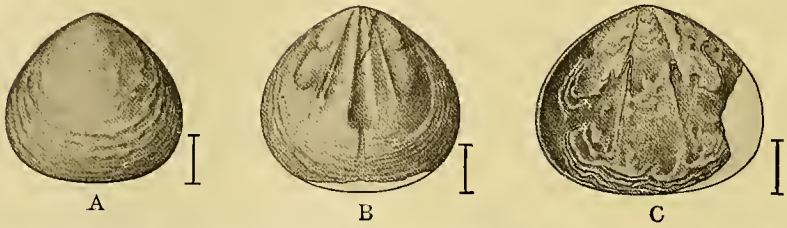


FIGURE 38.—*Obolus smithi* Walcott. A, Exterior of partly exfoliated ventral valve (U. S. Nat. Mus. Cat. No. 51611a). B, Exfoliated dorsal valve, the type specimen (U. S. Nat. Mus. Cat. No. 51611b). C, Partly exfoliated shell showing laminations (U. S. Nat. Mus. Cat. No. 51611c).

Figure 38B is copied from Walcott [1908d, Pl. VII, fig. 9a]. The specimens represented are all from Locality **56c**, near Helena, Alabama.

Surface marked by concentric lines of growth and numerous very fine, slightly irregular, undulating concentric ridges upon which numerous very minute papillæ occur, giving the surface, under a strong magnifying power, the appearance of being minutely granular.

A ventral valve 6 mm. in length has a width of 6.75 mm. A slightly larger dorsal valve 7.5 mm. in length has a width of 8 mm.

As shown in the cast, the area of the ventral valve is very short and divided by a relatively strongly marked, narrow pedicle furrow, the edges of which were elevated slightly above the general plane of the area. The cast of the interior shows that the visceral area was about two-fifths the length of the valve and that the main vascular sinuses extended rather directly forward from the umbo nearly to the front of the shell, separating very gradually and bounding the interior third of the valve. Nothing has been observed of the muscle scars.

The cast of the dorsal valve shows that it had a very short area that extended well out on the cardinal slopes; that a low central ridge extended a little more than half the length of the shell and was continued by a slight narrow median ridge; the main vascular sinuses extend directly and obliquely forward well toward the front of the shell in about the same relative position as in the ventral valve. The position of the transmedian and anterior lateral muscle

[a] See note accompanying the second reference in the synonymy of *Micromitra* (*Paterina*) *major* (p. 351) and the note following fig. 25, p. 351.

scars is indicated about halfway between the main vascular sinuses and the posterolateral margin of the valve.

Observations.—This species is characterized by its finely granular surface, short cardinal area, and relatively thick shell. It has the general form of *Obolus lamborni* (Meek) and *Obolus willisi* (Walcott), but it differs from both of these species in having a granulated surface and shorter cardinal area. It appears to be the Lower Cambrian form that is represented in the Middle Cambrian by *Obolus willisi* and in the Upper Cambrian by *Obolus lamborni*.

The specific name is given in honor of Prof. Eugene A. Smith, State geologist of Alabama.

FORMATION AND LOCALITY.—**Lower Cambrian**: (**17b**) Rome ("Montevallo") formation, 4 miles (6.4 km.) south of Helena; and (**56c**) *Rome ("Montevallo") formation, along road just north of Buck Creek, 1.125 miles (1.8 km.) northeast of Helena;* both in Shelby County, Alabama.

OBOLUS TETONENSIS Walcott.

Plate IX, figures 5, 5a–d.

Obolus tetonensis WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 684. (Characterized and discussed as below as a new species.)

Obolus tetonensis WALCOTT, 1905, idem, vol. 28, p. 327. (Copy of preceding reference, the species being given as new and no reference being made to the preceding citation.)

The general form, convexity, and appearance of this species are so much like those of *Obolus matinalis* (Hall) (Pl. VIII) that a general description is unnecessary. It varies from that species in the shorter, more transverse dorsal valve, and the narrower outline of the ventral valve toward the beak.

This species occurs in great abundance in the thin-bedded limestone in the upper portion of the Cambrian section of the Teton Range, Wyoming, in association with *Billingsella coloradoensis* (Shumard) and *Lingulella* (*Lingulepis*) *acuminata meeki* (Walcott). The forms from this horizon are illustrated by Plate X, figures 5, 5a, and 5b. What appears to be the same species occurs nearly 700 feet lower in the section in a thin-bedded sandstone. Specimens from this horizon are represented by Plate X, figures 5c and 5d. The dorsal valve (5d) is broader and more transverse posteriorly than the dorsal valve from the upper horizon.

This form owes its specific name to its occurrence in the Teton Mountains of Wyoming.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**161**) Limestone on the south side of West Gallatin (Gallatin) River, northwest of Hamilton on the north side of the Gallatin Valley; (**152b**)[a] east side of Dry Creek, below Pass Creek, Threeforks quadrangle (U. S. Geol. Survey); and (**148a**) limestone of the Gallatin formation at the head of Bostwick Canyon [Iddings and Weed, 1894, areal geology sheet[b]], in the Bridger Range, Livingston quadrangle (U. S. Geol. Survey); all in Gallatin County, Montana.

Middle Cambrian: (**4m**) Sandstones about 150 feet (45.7 m.) above the unconformable base of the Cambrian; and (**4e**) *limestones about 950 feet (289.6 m.) above the unconformable base of the Cambrian;* both in the divide at the head of Jackson Creek (locally known as Sheep Creek), a creek flowing into Jackson Lake about 0.5 mile (0.8 km.) south of its northwestern corner, Teton Mountains, Grand Teton quadrangle (U. S. Geol. Survey), Uinta County, Wyoming.

(**4h**) About 375 feet (114.3 m.) above the base of the Cambrian in limestone interbedded in the Flathead shales of Peale [1893, p. 21], 1 mile (1.6 km.) north of the junction of East Gallatin and West Gallatin (Gallatin) rivers, 4 miles (6.4 km.) east-northeast of Logan, Threeforks quadrangle (U. S. Geol. Survey), Gallatin County; and (**4x**) limestone interbedded in the Wolsey shale [Weed, 1900, p. 285], at the base of a butte in Belt Park, about 6 miles (9.6 km.) northwest of Neihart, Little Belt Mountains quadrangle (U. S. Geol. Survey), Cascade County; both in Montana.

(**3e**) Thin-bedded limestones less than 400 feet (121.9 m.) above the quartzitic sandstones of the Cambrian, at Ophir, Oquirrh Range, Tooele County, Utah.

(**14x**) About 400 feet (122 m.) above the bottom of Tombstone Gulch in the Abrigo limestone [Ransome, 1904, p. 3], in the northwest suburb of Bisbee [Ransome, 1904, areal geology sheet], Cochise County, Arizona.

OBOLUS TETONENSIS LEDA Walcott.

Obolus tetonensis leda WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 63. (Characterized as below as a new variety.)

This is the Upper Cambrian representative of *Obolus tetonensis* Walcott of the Middle Cambrian of the Teton Mountains. Stratigraphically it occurs over 2,000 feet higher in the Cambrian

[a] This species is somewhat doubtfully identified from this locality.

[b] Iddings, J. P., and Weed, W. H., Livingston folio (No. 1), Geol. Atlas U. S., U. S. Geol. Survey, 1894.

section, and the localities are 400 miles apart. The variety *leda* differs from the species in having more numerous fine threadlike striæ and in having the ventral valve on the average more obtuse in old shells.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**30m**) About 1,950 feet (584.4 m.) above the Middle Cambrian and 1,350 feet (411.5 m.) below the top of the Upper Cambrian in the siliceous limestones forming 1e of the Notch Peak limestone [Walcott, 1908f, p. 175], on the slopes of Notch Peak, about 5 miles (8 km.) southwest of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah.

OBOLUS TETONENSIS NINUS Walcott.

Plate VIII, figures 11–o; Plate XI, figures 1, 1a–g.

Obolus tetonensis ninus WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 328. (Characterized essentially as below as a new variety.)

This variety differs from *Obolus tetonensis* Walcott and from *O. matinalis* (Hall) by the more elongate form of the dorsal valve and the more acuminate form of the ventral valve, the cardinal slopes of the latter extending much farther forward in the variety *ninus* than in the two species.

The advanced position of the visceral area in the ventral valve is shown by Plate XI, figure 1b, and in the dorsal valve by Plate XI, figure 1g. The advanced position of the latter may be compared with the visceral area of *Obolus* (*Schmidtia*) *crassus* Mickwitz.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**12m**) Arbuckle limestone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 30 feet (9.1 m.) above the Reagan sandstone), NE. ¼ sec. 2, T. 2 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County; (**12k**) limestones of the Reagan sandstone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 225 feet (69 m.) above the porphyry contact and 55 feet (17 m.) below the Arbuckle limestone), on the west side of Honey Creek, near the southeast corner of sec. 35, T. 1 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County; (**12n**) limestones of the Reagan sandstone (15 feet above 12k in the Springer section), NW. ¼ sec. 1, T. 2 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County; and (**12p**) about 225 feet (69 m.) above the igneous rocks in the limestones of the Reagan sandstone, at the northwest extremity of the Arbuckle Mountains, about 4 miles (6.4 km.) east of Homer, Carter County; all in Oklahoma.

(**9q**) About 10 feet (3 m.) above the porphyry contact and 90 feet (27.4 m.) below the Arbuckle limestone, in limestones of the Reagan sandstone, in middle of W. ½ sec. 2, T. 4 N., R. 13 W.; (**9p**, **9r**, and **9t**)[a] *from 45 to 170 feet (14 to 52 m.) above the porphyry contact in the limestones of the Reagan sandstone, in SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W.;* (**9s**) about 85 feet (26 m.) below the Arbuckle limestone in the limestones of the Reagan sandstone, near middle of W. ½ sec. 13, T. 4 N., R. 13 W.; and (**9u**) about 195 feet (59.4 m.) above the porphyry contact in the limestones of the Reagan sandstone in SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W.; all about 15 miles (24.2 km.) northwest of Fort Sill, Comanche County, Oklahoma.

(**68**) Interbedded sandstone and limestone, Packsaddle Mountain, Llano County, Texas.

(**54w**) Limestone of the St. Charles formation [Walcott, 1908a, p. 6], about 250 feet (76 m.) above the Middle Cambrian on the north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

OBOLUS ? TORRENTIS Matthew.

Obolus torrentis MATTHEW, 1902, Trans. Roy. Soc. Canada, 2d ser., vol. 8, sec. 4, No. 3, p. 94, Pl. I, fig. 1. (Mentioned as a new species.)

Obolus torrentis MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 76, Pl. VIII, fig. 1. (Described and discussed as a new species. Fig. 1 is copied from fig. 1 of the preceding reference.)

The type material representing this form is too imperfect for specific determination. A crushed and distorted dorsal valve, and the interior of a crushed ventral valve that suggests *Lingulella triparilis* (Matthew) (Pl. XLV) are all Doctor Matthew sent me. The difference in stratigraphic horizon between the shales containing *O.? torrentis* and the shales bearing *Lingulella triparilis* is not great, and but for the presence of an interbedded mass of "felsites" they would probably have been considered as belonging to one formation.

The specific name is derived from its occurrence near the great falls (torrent) in Dugald Brook.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**13k**)[b] Shales of Matthew's [1903, p. 15] Coldbrook, above the great falls in Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

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[a] **9r** is the type locality.

[b] The specimens to which Locality **13k** was assigned were collected one year later than those described by Doctor Matthew [1902, p. 94] but from the same locality.

Obolus triangularis Mickwitz.

Obolus triangularis Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 145–147, Pl. II, figs. 7–9. (Described and discussed in German as a new species; see below for translation of diagnosis.)

Obolus triangularis inornatus Mickwitz, 1896, idem, pp. 148–149, Pl. II, figs. 10–12. (Described and discussed in German as a new variety.)

Obolus triangularis Mickwitz, Moberg and Segerberg, 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), p. 65. (New locality mentioned in Swedish.)

Obolus triangularis Mickwitz, Westergård, 1909, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 4 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 20), p. 56. (Locality mentioned in Swedish.)

The original description by Mickwitz follows:

Shells moderately large, slightly grooved, thin, brittle; outline of shell subtriangular, posterior border of shells rectilinear, not winged; surface slightly shiny, concentric striæ in fine ribs, which converge to the border of the shell, either diverging or confluent, running somewhat irregularly, separated by deep, rounded grooves; radial striæ dwindling, indefinite. Area large, splanchnocœlic part broad, peduncular groove wide, parallel bordered, opening toward the inside of the shell. Central groove of the large shell heart-shaped to subpentagonal, slightly swelled. Median septum and lateral septa perceptibly developed. Sinus of small shell reaching nearly to the area, corneous processes ridge-shaped. Combined central places for the attachment of muscles of the large shells are not prolonged into grooves posteriorly.

Mickwitz states that the shells of this species are very thin and brittle and that in the enormous mass of loose *Obolus* conglomerate that he examined at Joa not one thick-shelled specimen was found. The shell also occurs alone at Reval under the *Obolus* conglomerate, and they are so delicate that they can not be taken from the matrix, although it is a very loose, fine-grained sandstone. The thick shells of the *Obolus* conglomerate have a more confused ornamentation and a somewhat wider form. The concentric ribs of the typical form have the best development near the center of the shell, where they run together and are dotted in places with indistinct knots formed by the intersection of the irregularly developed radial striæ with the concentric striæ. He calls attention to the broad pedicle groove of the ventral valve, which is of the same type as that of *O. panderi* Mickwitz, and describes in detail the interior markings of the valves.

The variety *inornatus* does not appear to me to be sufficiently distinct to be entered as a variety.

Formation and locality.—**Upper Cambrian:** (**395g**) *Obolus conglomerate at Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval;* (**395i**) *Obolus* conglomerate at Ilgast; and (**336i**) sandstone below the *Obolus* conglomerate proper, at Reval; all [Mickwitz, 1896, p. 147] in the Government of Esthonia, Russia.

(**9d**) *Obolus* sandstone at Jaggowal, about 20 miles (32 km.) east-southeast of Reval, Government of Esthonia, Russia.

(**310n**) *Obolus* sandstone? [Moberg and Segerberg, 1906, p. 65], in Dalarne, Province of Kopparberg, Sweden.

Obolus volborthi Mickwitz.

Obolus volborthi Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 155–157, Pl. II, figs. 16–17. (Described and discussed in German as a new species.)

This species is separated from *O. eichwaldi* Mickwitz on the difference in the character of the surface. Of this species only three fragments have been found. According to Mickwitz, it is distinguished from *O. eichwaldi* by its oval outline and pronounced inclination of the beak. He gives a detailed description and comparison, to which the student is referred.

The specific name was given in honor of Dr. A. von Volborth.

Formation and locality.—**Upper Cambrian:** (**395** [Mickwitz, 1896, p. 157]) *Obolus* sandstone at Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval, Government of Esthonia, Russia.

Obolus willisi (Walcott).

Plate XXIII, figures 1, 1a–j.

Obolus (*Lingulella*) *willisi* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 418–419. (Described and discussed as below as a new species.)

General form broadly ovate, with the ventral valve obtusely acuminate and the dorsal valve almost transversely ovate, the posterior margin being very broadly obtuse; convexity moderate in the specimens preserved in the calcareous sandstone. Surface of shell marked by concentric lines and striæ of growth, with very fine irregular striæ between them; a few specimens show very narrow, slightly irregular, interrupted, radiating ridges or undulations (Pl. XXIII, fig. 1j); inner surface of the shell more or less strongly pitted or punctate. This character varies greatly in casts from the same layer of shale, as may be seen by comparing Plate XXIII, figure 1b, where it is extreme, with Plate XXIII, figures 1a, 1e, and 1h. The shell, as preserved in the argillaceous shale, is relatively thin.

The largest ventral valve, which is shortened slightly by distortion, has a length of 10 mm.; width, 8.5 mm. A well-preserved dorsal valve 8.5 mm. in length has the same width, while another associated dorsal valve 6.5 mm. in length has a width of 7 mm.

As shown in the casts, the area of the ventral valve is rather long and is divided midway by a strong cast of the pedicle furrow, and again midway between the pedicle furrow and the lateral margins by a well-defined flexure line; fine striæ of growth cross the area parallel with its base. The area of the dorsal valve is relatively short and extends far out onto the cardinal slopes; it is marked by clearly defined but not strong flexure lines. Casts of the interior of the ventral valve show traces of the visceral cavity (v) and the main vascular sinuses (vs). In the dorsal valve a narrow median septum is all that is shown, with the exception of faint indications of the central and anterior lateral scars (h and j) (Pl. XXIII, fig. 1g) and what appears to be the transmedian (i) (Pl. XXIII, fig. 1e).

Observations.—This species was at first compared with *Obolus lamborni* (Meek) (Pl. XXII). Like that, it has a strongly pitted or punctate inner surface, and the ventral valve has the same general outline. The dorsal valve, however, is much more transverse and obtuse, and the central muscle scars in the dorsal valve appear to be somewhat differently located.

This species has considerable vertical range; some of the specimens associated with the Middle Cambrian fauna in the Conasauga shale are very much like *O. lamborni* from the Rogersville shale of Tennessee.

I take pleasure in naming the species in honor of Mr. Bailey Willis, who for a considerable time had charge of the work in the region where these specimens were collected by Dr. Cooper Curtice.

Formation and locality.—**Upper Cambrian**: (**93**) Shales and limestones at the base of the Knox dolomite, near Jordan's, just below the ford on Cowan Creek; (**93n**) shales in the southern part of Jordan's farm, near Jordan's crossroads; and (**93x**) shales on the Clarke farm, near the ford across Cowan Creek, about 2 miles (3.2 km.) north of Jordan's crossroads; all about 8 miles (12.8 km.) southeast of Center, Cherokee County, Alabama.

(**96b**) Shales in a railroad cut on the Southern Railway, near Cave Spring, 10 miles (16.1 km.) southwest of Rome, Floyd County, Georgia.

(**122**) Shale southwest of Town Knobs, 1 mile (1.6 km.) northwest of Rogersville, Hawkins County, Tennessee.

Middle Cambrian: (**146**) Conasauga shale on the Jacksonville road, 8 miles (12.8 km.) east of Center; (**91**) Conasauga shale at Cedar Bluff; (**94**) shales 0.25 mile (0.4 km.) beyond Steel Ford, Cowan Creek, about 8 miles (12.8 km.) southeast of Center; and (**94a**) Conasauga shale, in Coosa Valley, east of Center; all in Cherokee County, Alabama.

(**140a**) *Shales 200 yards (182.9 m.) east of Thomas Mills, 5 miles (8 km.) north of Cave Spring [Hayes, 1902, historical geology sheet], Floyd County, Georgia.*

(**101b**) Rogersville shale, just east of the schoolhouse, 3.5 miles (5.6 km.) southwest of Rogersville, on the road to Melinda Ferry [Keith, 1896a, areal geology sheet], Hawkins County; (**107a** and **107b**) shales and sandstone of the Rome formation in railroad cut in Bull Run, northwest of Copper Ridge [Keith, 1896b, areal geology sheet], 11 miles (17.6 km.) northwest of Knoxville, Knox County; (**14a**) sandstone of the Rome formation along First Creek Gap, 4 miles (6.4 km.) north-northeast of Knoxville [Keith, 1905, areal geology sheet], Knox County; (**106a**) reddish-brown shales in middle of valley east of Shooks Ridge, in Bays Mountains, 10 miles (16.1 km.) southeast of Knoxville, Knox County; (**374e**) shales collected near the State line, 2.25 miles (3.6 km.) north of Peltier, Estillville quadrangle (U. S. Geol. Survey), Sullivan County; and (**121**) Rogersville shale, road just east of Harlan Knob, 4 miles (6.4 km.) northeast of Rogersville [Keith, 1905, areal geology sheet], Hawkins County; all in Tennessee.

Obolus wortheni Walcott.

Text figures 39A–D; Plate IX, figure 5e.

Obolus wortheni Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 63–64, Pl. VII, fig. 17. (Described and discussed as below as a new species. Fig. 17, the type specimen, is copied in this monograph, Pl. IX, fig. 5e.)

General form subcircular, with the ventral valve very obtusely acuminate and the dorsal valve slightly transverse; both valves slightly convex. Ventral valve with the beak at the posterior margin, which rises slightly from the general plane of the margin of the valve; the minute beak of the dorsal valve is at the posterior margin.

Surface marked by sharp, fine, concentric striæ and fine imbricating lines of growth; on some shells low, irregular, more or less obscure and interrupted radiating ridges occur. Shell of medium thickness and built up of several layers or lamellæ. The average diameter of the valves is 3 mm.

The interior of the ventral valve shows a short flat area divided midway by a narrow pedicle furrow; the visceral area, which is about one-third the length of the valve, is shown only in outline; the main vascular sinuses are strong and situated about midway between the median line and the lateral margins of the valve; the surface outside the visceral area in both valves is marked by fine concentric furrows and large scattered punctæ, much like those of *Obolus* (*Westonia*) *escasoni* (Matthew) (Pl. XLIX, figs. 1a and 1aa). The interior of the dorsal valve has a short area with a broad pedicle groove; strong curved main vascular sinuses extend from beneath the area well toward the front of the valve; they are subparallel to the margin and are situated about one-third the distance from the margin to the median line of the valve; the visceral area is outlined in about one-half the length of the valve; a narrow, deep sinus extends from each side of the anterior end and then curves outward to the front margin (Pl. IX, fig. 5e).

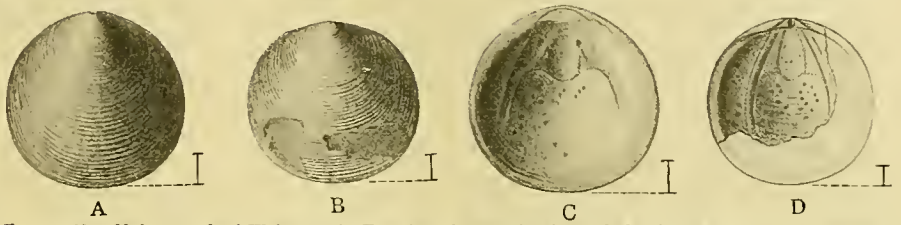

Figure 39.—*Obolus wortheni* Walcott. A, Exterior of ventral valve (U. S. Nat. Mus. Cat. No. 51638b). B, Exterior of dorsal valve (U. S. Nat. Mus. Cat. No. 51638c). C, Interior of ventral valve (U. S. Nat. Mus. Cat. No. 52431). D, Interior of ventral valve (U. S. Nat. Mus. Cat. No. 51638d).

The specimens represented by figures 39A, 39B, and 39D are from Locality **54u**, that represented by figure 39C is from Locality **54t**, both near Malade, Idaho.

Observations.—This shell was at first thought to be the young of *Obolus tetonensis* Walcott, but with the finding of a good series it was found to have a nearly circular ventral valve instead of subacuminate as in *O. tetonensis*, and it is less convex in the same character of matrix. In form *Obolus wortheni* resembles *Obolus discoideus* (Hall and Whitfield) (Pl. XVIII, figs. 6, 6a–d), but it differs in being more circular in outline and in having a thinner shell.

The specific name was given in honor of A. H. Worthen.

Formation and locality.—**Upper Cambrian**: (**5a**, **5c**, **54t**, and **54w**) Limestone about 250 feet (76 m.) above the Middle Cambrian; (**54x**) limestone about 200 feet (60.4 m.) above the Middle Cambrian; and (**54u**) *limestone about 100 feet (30.2 m.) above the Middle Cambrian;* all in the St. Charles formation [Walcott, 1908a, p. 6], on the north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

Middle Cambrian: (**54v**) Limestone in the lower part of the Bloomington formation [Walcott, 1908a, p. 7], about 1,600 feet (488 m.) below the Upper Cambrian, on the south side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

Obolus zetus (Walcott).

Plate XXV, figures 3, 3a–c.

Obolus (*Lingulella*) *zetus* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 419. (Characterized and discussed as below as a new species.)

This is a small shell that has somewhat the general form of *Obolus lamborni* (Meek). It differs, however, in being more transverse across the front, in having a broad, shallow

depression in the dorsal valve, and also in being flattened across the center of the ventral valve. It occurs at a higher horizon than *Obolus* (*Westonia*) *chuarensis* (Walcott), *O.* (*W.*) *euglyphus* (Walcott), and *Lingulella lincolata* (Walcott) of the upper beds of the "Tonto" sandstone. It has more the form of the true *Obolus* than those species, but its shell is relatively thin and marked by fine radiating striæ. All of its essential characters are well shown by the figures illustrating the species.

FORMATION AND LOCALITY.—**Upper Cambrian:** (75) Thin-bedded limestones just below the base of the Ordovician in the Tonto group, near the water's edge at the mouth of Kanab Canyon, Grand Canyon of the Colorado, Arizona.

Middle Cambrian: (74) *Sandstone about 300 feet (91.4 m.) above the base of the Tonto group, at the head of Nunkowcap Valley, Grand Canyon of the Colorado, Arizona.*

(358b) Limestone on the southwest side of Escabrosa Ridge, 4.5 miles (7.2 km.) west-southwest of Bisbee, Arizona.

OBOLUS? ZOPPI Walcott.

Plate XXX, figures 16, 16a–b.

Obolella crassa BORNEMANN [not HALL], 1891, Nova Acta Acad. Cæs. Leop.-Carol. Germanicæ Naturæ Curiosorum, Bd. 56, No. 3, pp. 439–440, Pl. XIX, figs. 15–17. (Described and discussed in German; see below for translation. Figs. 16, 17a, and 17b are copied in this monograph, Pl. XXX, figs. 16a, 16, and 16b, respectively, 16b being the side view of the specimen represented by fig. 16.)

Obolus? zoppi WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 684–685. (Original description translated and species discussed as below as a new species.)

The original description by Bornemann follows:

Broadly oval or circular, with somewhat pointed vertex. Shells strongly arched, one somewhat more so than the other. They are marked with prominent concentric lines; no radial striation is noticed. Found in a red-yellow sandstone layer not far from the houses of Canal Grande on the road to Punta Pintau, Sardinia.

In view of the imperfect state of preservation, a determination can only be based on the outer form, whose habit agrees with the American species from the Cambrian limestone of Troy.

Bornemann kindly sent me two specimens of this form. They suggest *Obolella crassa* (Hall) in form and outline, but the material is too imperfect to identify the species or genus. I find in one specimen indications of the presence of a high area that rises slightly above the plane of the ventral valve. In two casts there is nothing to suggest the cast of the pedicle aperture, which is usually well preserved in casts of the ventral valve of specimens of *Obolella atlantica* Walcott. As the material is probably from the Middle Cambrian, a provisional reference is made to *Obolus*.

FORMATION AND LOCALITY.—**Middle Cambrian:** (354f [Bornemann, 1891, p. 439])[a] Reddish-yellow sandstone near the houses of Canal Grande on the road to Punta Pintau, island of Sardinia, Italy.

OBOLUS sp. undt. a.

Plate X, figure 4.

A small *Obolus*-like shell, which occurs in the dark argillaceous shales above the Upper Cambrian zone of eastern New York, resembles in outline *Obolus* (*Bröggeria*) *salteri* (Holl) (Pl. XIII) of England and Sweden. All the specimens are flattened in the shale. No distinctive specific characters except a series of well-defined concentric striæ are shown.

FORMATION AND LOCALITY.—**Ordovician:** (338v) Shale 1 mile (1.6 km.) southwest of Middle Granville, Mettawee quadrangle (U. S. Geol. Survey), Washington County, New York.

OBOLUS sp. undt. b.

A small shell marked by very distinct concentric striæ and very faint radiating striæ occurs at the following locality. The material is too imperfect for illustration.

FORMATION AND LOCALITY.—**Upper? Cambrian:** (7n) Limestone at Hornet Spring in the Spring Mountain Range, on road from Indian Spring to Pahrump Valley, Lincoln County, Nevada.

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[a] Specimens from this locality are included in the collections of the United States National Museum.

Obolus sp. undt. c.

An exfoliated dorsal valve, probably belonging to the genus *Obolus*, occurs at the following locality. The specimen is too imperfect for identification.

Formation and locality.—**Ordovician**: (**214a**) Limestone near the base of the Pogonip limestone in the White Pine district, White Pine County, Nevada.

Obolus sp. undt. d.

In the conglomerate limestone near Highgate Falls, Vermont, I collected a single specimen of the ventral valve of a species of *Obolus* not unlike the ventral valve of *Obolus mæra* (Hall and Whitfield) (Pl. X) of the Rocky Mountain region.

Its surface is marked by numerous fine radiating striæ and by distinct, concentric, lamellose lines of growth. The fossils associated with it in the same fragment of limestone indicate the Upper Cambrian horizon.

Formation and locality.—**Upper Cambrian**: (**87′**) Conglomeratic limestone 1 mile (1.6 km.) south-southwest of Highgate Falls, Franklin County, Vermont.

Obolus sp. undt. e.

Plate XV, figure 8.

Obolus sp. Kayser, 1876, Beiträge zur Geologie und Paleontologie der argentinischen Republik, vol. 2, Paleontol. Theil, Abth. 1, pp. 9–10, Pl. I, fig. 14. (Described and discussed in German. Fig. 14 is copied in this monograph, Pl. XV, fig. 8.)

This form is illustrated by a single specimen of what appears to be the ventral valve. Kayser [1876, p. 9] states that most of the specimens are mere fragments and only the genus can be determined. He suggests that it may be *Obolella*, but from our present knowledge of that genus it is not probable. The figure recalls forms of *Obolus matinalis* (Hall) and *O. anceps* Walcott.

Formation and locality.—**Upper Cambrian**: (**389b** [Kayser, 1876, p. 9]) Sandstone at Tilcuya, Province of Jujuy, Argentina, South America.

Obolus? sp. undt. f.

Plate XV, figure 9.

Lingulella sp. Kayser, 1883, China, by Richthofen, vol. 4, p. 35, Pl. III, fig. 2. (Characterized and discussed in German. Fig. 2 is copied in this monograph, Pl. XV, fig. 9.)

Kayser [1883, p. 35] states that the remains of this species available for study are too imperfect to permit accurate description and comparison. The shell preserves traces of radial striation and strong concentric striæ of growth. Attention is called to the fact that it has a somewhat similar outline to *Lingulella nathorsti* Linnarsson (Pl. XXXI).

The resemblance to the *Obolus* described by Kayser [1876, p. 9] from Tilcuya, Argentina, is noticeable, and like that species it recalls *Obolus matinalis* (Pl. VIII). Comparison should also be made with *Dicellomus politus* (Hall).

Formation and locality.—**Upper Cambrian**: (**332** [Kayser, 1883, p. 35]) Limestone at Saimaki, Province of Liaotung, China.

Obolus sp. undt. g.

Obolus (?) sp. indet., Linnarsson, 1876, Bihang till K. svensk. Vet.-Akad. Handl., Bd. 3, No. 12, p. 16, Pl. III, fig. 31. (Described and discussed in English. See below for copy of description.)

The original description by Linnarsson follows:

Because of its general shape, I refer to the genus *Obolus* a species of which the materials are very unsatisfactory, so that I will not create for it a specific name, though it is easily distinguished from all the primordial Brachiopoda of Sweden. The best specimen is an interior, somewhat mutilated anteriorly, and with the innermost shell layers partly exfoliated. Its width is 16 mm., the length about 14 mm. The shell is very slightly convex; its circumference resembles a sector of a circle; the front is broadly rounded; the slopes forming the beak seem to be nearly straight, and make a

somewhat obtuse angle. The surface is not well preserved in any specimen; judging, however, from some small fragments, I should think that a concentric striation is prevailing, but that there are also radiating ribs. In the inner shell layers little more than a longitudinal striation is seen; the innermost are perforated by small punctiform pits. The inner layers are polished and glossy; the outermost seems to be opaque.

FORMATION AND LOCALITY.—**Middle Cambrian**: (3201 [Linnarsson, 1876, p. 16]) Drift blocks supposed to have come from the *Paradoxides œlandicus* zone [Linnarsson, 1876, p. 6], at Lillviken, near Oestersund, Province of Jemtland, Sweden.

BRÖGGERIA Walcott,[a] subgenus of OBOLUS.

Obolus (*Bröggeria*) WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 605. (Characterized as below as a new subgenus.)
Obolus (*Bröggeria*) WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 144. (Classification of genus.)

This subgenus differs from the typical forms of *Obolus* in having a very deep visceral depression in both valves and a minutely punctate interior surface. A series of shells showing the effect of compression on the appearance of the interior casts of the valves is illustrated on Plate XIII.

Type.—Obolella salteri Holl.

The generic name was given in honor of Dr. W. C. Brögger.

OBOLUS (BRÖGGERIA) SALTERI (Holl).

Plate XIII, figures 1, 1a–n; Plate XV, figures 4, 4a–d.

Obolella salteri HOLL, 1865, Quart. Jour. Geol. Soc. London, vol. 21, pt. 1, p. 102, figs. 9a–b. (Described as a new species; see below for copy. Figs. 9a–b are copied in this monograph, Pl. XV, fig. 4.)
Obolella salteri Holl?, DAVIDSON, 1866, British Fossil Brachiopoda, vol. 3, pt. 7, No. 1, pp. 61–62, Pl. IV, figs. 28 and 29. (Original description, Holl, 1865, p. 102, copied and species discussed. Fig. 28 is copied from Holl, 1865, figs. 9a–b.)
Obolella? salteri Holl, DAVIDSON, 1868, Geol. Mag., vol. 5, p. 311, Pl. XVI, figs. 8–9. (Discussed.)
Obolus? salteri (Holl), DALL, 1870, Am. Jour. Conchology, 2d ser., vol. 6, pt. 2, p. 163. (Discussed.)
Obolella salteri Holl, PHILLIPS, 1871, Geology of Oxford and the Valley of the Thames, p. 68, Diagram XVII, fig. 11. (No text references.)
Obolus salteri (Holl), BRÖGGER, 1882, Die silurischen Etagen 2 und 3, pp. 44–45, Pl. X, figs. 10, 11, and 13. (Localities mentioned in German. The specimen represented by fig. 10 is redrawn in this monograph, Pl. XIII, fig. 1m.)
Obolus? salteri (Holl), MICKWITZ, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, p. 19. (Discussed in German.)
Obolella (?) salteri Holl, MATLEY, 1902, Quart. Jour. Geol. Soc. London, vol. 58, pt. 1, pp. 139–140, figs. 3–6, p. 138. (Described and discussed.)
Obolus (*Bröggeria*) *salteri* (Holl), WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 605–606. (Original description, Holl, 1865, p. 102, copied as below, and species discussed essentially as below?)
Obolus (*Bröggeria*) *salteri* (Holl), MOBERG and SEGERBERG, 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), p. 64, Pl. I, figs. 27–30. (Described and discussed in Swedish.)
Obolus (*Bröggeria*) *salteri* var.? WESTERGÅRD, 1909, Medd. från Lunds Geol. Fältklubb, Ser. B., No. 4 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 20), p. 56, Pl. II, figs. 17–19. (Discussed in Swedish. Figs. 17 and 18 are copied from Moberg and Segerberg, 1906, Pl. I, figs. 28 and 27, respectively.)

The original description by Holl follows:

Compressed, subtriangular to nearly round, rather broader than long; shell thin; surface grooved concentrically by a few inequidistant, strongly marked lines of growth and by numerous finer lines which are distinct only on the sides of the shell. Length usually about one-third inch, width slightly more.

Position.—In the Black Shales.

Brögger [1882, Pl. X, figs. 10, 11, and 13] identified this species from both the *Ceratopyge* slate and the *Ceratopyge* limestone of Sweden. The specimen from the limestone is very beautifully preserved and appears to be the dorsal valve of this species.

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a The synonymy for this subgenus does not give a complete record of the various genera under which the species now included in *Bröggeria* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic refereuces are listed:

Obolella Holl [1865, p. 102].
Obolella Davidson [1866, p. 61; 1868, p. 163].
Obolus? Dall [1870, p. 163].
Obolella Phillips [1871, p. 68].
Obolus Brögger [1882, p. 44].
Obolus? Mickwitz [1896, p. 19].
Obolella? Matley [1902, p. 139].
Obolus (*Bröggeria*) Moberg and Segerberg [1906, p. 64].

I find in the limestone from Slemmestad a broad form of the ventral valve that closely resembles in outline and surface the shell illustrated by Brögger as "*Lingula* sp." [Brögger, 1882, Pl. X, fig. 9], and I think that the specimen represented by figure 12 of the same reference ("*Lingula* sp.") may also belong to this species.

Through the courtesy of Doctor Brögger, I studied the material representing this species collected in Norway, including the fine interior of the dorsal valve illustrated on Plate XIII, figure 1m, of this monograph.

In a collection kindly sent me by Dr. G. Lindström I find two ventral valves (Pl. XV, figs. 4a and 4b) from the black shale of Skåne, but it is in the collection made by Mr. Schmalensee that specimens occur showing the casts of the interior of the dorsal valve. These have the imprint of the central visceral area, the large vascular sinuses, and the area (Pl. XV, fig. 4c). A cast (Pl. XIII, fig. 1b) of an uncompressed shell proves that the visceral area was short and relatively small. Comparing the latter figure with Plate XIII, figure 1m, I am led to conclude that the latter is a partly exfoliated specimen preserving the vascular markings on the thin inner layers of the shell.

In Cape Breton this species occurs abundantly in association with *Lingulella concinna* Matthew and *Acrotreta bisecta* Matthew. The shells are all compressed in the shale, but a direct comparison of the interiors of the valves of specimens from Cape Breton and the *Ceratopyge* shales of Sweden shows the two to be identical in all characters except the length of the area and pedicle groove. The Cape Breton shells have a longer area, but whether or not this is due to the conditions of preservation I am unable to decide, as the material from Sweden is very imperfect about the area. On one of the Cape Breton shells the fine punctæ of the interior surface are clearly shown.

The specific name was given in honor of Mr. J. W. Salter.

FORMATION AND LOCALITY.—**Passage beds** between the Upper Cambrian and the Ordovician: (**8x**) *Ceratopyge* limestone at Slemmestad, about 3 miles (4.8 km.) southwest of Christiania; (**323i** [Brögger, 1882, description of Pl. X]) *Phyllograptus* slate at Krekling, in Sandsvär; (**323e** [Christiania Univ. Min. Inst.]) *Ceratopyge* limestone (Étage 3aγ of Brögger) at Engervik, in the Christiania region; (**323f** [Brögger, 1882, pp. 16–17]) lower part of the *Ceratopyge* limestone at Vestfossen, 10 miles (16.1 km.) west-southwest of Christiania; and (**323h** [Brögger, 1882, p. 17]) blue *Ceratopyge* limestone (a higher horizon than 323f) at Vestfossen, 10 miles (16.1 km.) west-southwest of Christiania; all in Norway.

(**309** [Moberg and Segerberg, 1906, description of Pl. I]) *Ceratopyge* limestone (zone 4 of Moberg and Segerberg) at Fogelsång, 5 miles (8 km.) east of Lund; and (**323j** [Brögger, 1882, p. 44]) *Ceratopyge* limestone at Tosterup; both in the Province of Malmöhus, Sweden.

Upper Cambrian: (**304e** [*Davidson, 1866, p. 62*]) *Upper part of the black "White Leaved Oak" shales at Coal Hill, east end of the Malvern Hills;* and (**304a** [Groom, 1902, p. 110]) "Bronsil" shales in the Malvern Hills; both between Herefordshire and Worcestershire, England.

(**3q**) Shale in Barachois Glen, 4 miles (6.4 km.) south of Little Bras d'Or Lake; (**10c**) shale on west side of Barachois River; (**10d**) shales on west side of Barachois River, 0.125 mile (0.2 km.) north of Boisdale road, opposite McMullin's place; (**10m**) shales 2 miles (3.2 km.) south of the Boisdale road from Upper Leitches Creek, toward the head of Barachois River; (**10e**, **10f**, and **10g**) shales on the east branch of Barachois River, 0.5 mile (0.8 km.) north of the crossroad from Boisdale to Upper Leitches Creek; (**10i**) shale in high bank on west side of Barachois River, just north of the Boisdale road; (**10l**) shale on east bank of Barachois River, 6 miles (9.6 km.) from Little Bras d'Or Lake; (**3h**) shale and shaly limestone on McNeil Brook, 1.5 miles (2.4 km.) east of Marion Bridge; (**10n**) shale in ravine on east side of Barachois Glen, 3 miles (4.8 km.) from Barachois; (**13h**) shale on east bank of Barachois River, 1.5 miles (2.4 km.) north of Boisdale; and (**10r**) arenaceous shales of Division C3a? of Matthew at McAdam Shore, East Bay, east of Bras d'Or Lake; all in eastern Cape Breton, Nova Scotia.

(**323w**) Black argillaceous shale of Étage 3aβ at Christiania, Norway.

(**390i**) Limestone band in *Ceratopyge* slate at Borgholm; (**309j**) shale at Alunbruk (alum works); (**310d**) *Ceratopyge* slate at Borgholm; and (**321x**) *Dictyograptus* slate at Alunbruk (alum works); all on Oeland Island, Sweden.

(**390g** [Moberg and Segerberg, 1906, p. 64])[a] Limestone in the *Dictyograptus* slate at Sandby, 6 miles (9.6 km.) east-northeast of Lund; (**309h**) limestones of the *Dictyograptus flabelliformis* zone at Fogelsång, 5 miles (8 km.) east of Lund; (**323k** [Brögger, 1882, p. 44]) *Ceratopyge* slate at Tosterup; and (**309i**) limestones at Sandby, 6 miles (9.6 km.) east-northeast of Lund; all in the Province of Malmöhus, Sweden.

Upper? Cambrian: (**309l**) Shale collected somewhere in Sweden, exact locality unknown; and (**310h**) shale collected somewhere (probably Fogelsång) in the old province of Skåne, now the Provinces of Malmöhus and Christianstad; both in Sweden.

[a] Specimens from this locality are included in the collections of the United States National Museum.

PALÆOBOLUS Matthew,[a] subgenus of OBOLUS.

[παλαιός, ancient; and Obolus.]

Palæobolus Matthew, 1899, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 3, No. 18, pp. 201–202. (Described and discussed as a new subgenus, likely of *Obolus*, though that does not appear in the text.)

Palæobolus Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 140–141. (Copies the first paragraph of the preceding reference and mentions the form as a subgenus. On subsequent pages (144 and 146) the name occurs as *Obolus* (*Palæobolus*).)

Obolus (*Palæobolus*) (Matthew), Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 144. (Classification of subgenus.)

Characterized by an approximation of the main vascular canals and surface markings. The surface is of the same type as that of *Obolus* (*Acritis*) *antiquissimus* (Eichwald) (Pl. XIII), but the position of the visceral cavity and vascular canals differs materially in the two forms.

Type.—*Palæobolus bretonensis* Matthew.

Obolus (Palæobolus) bretonensis (Matthew).

Plate XXXII, figures 5, 5a–g.

Palæobolus bretonensis Matthew, 1899, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 3, No. 18, p. 202, Pl. II, figs. 2a–i. (Described and discussed. The first reference, though it is not described as a new species.)

Obolus bretonensis Matthew, 1902, Trans. Roy. Soc. Canada, 2d ser., vol. 8, sec. 4, No. 3, p. 95, Pl. I, figs. 5a–e. (Characterized. Figs. 5a–e are copied from Matthew, 1899, Pl. II, figs. 2a–e.)

Palæobolus bretonensis Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 141–143, Pl. IX, figs. 2a–h. (Original description, Matthew, 1899, p. 202, copied and species redescribed and discussed. The species is mentioned on p. 143 as *Obolus bretonensis*. Figs. 2a–h of this reference are copied from Matthew, 1899, Pl. II, figs. 2a–e, 2i, 2g, and 2h. Some of the specimens used by Matthew in preparing his illustrations are copied in Pl. XXXII of this monograph. Close identification is impossible, but figs. 5, 5b, 5c, and 5e of Pl. XXXII may represent the specimens used by Matthew for figs. 2b, 2d, 2a, and 2e, respectively, of Pl. IX of his paper.)

General form rounded ovate, with the ventral valve subacuminate and the dorsal valve sometimes transversely ovate, the cardinal slope meeting at the beak to form a very broad angle. Valves moderately convex in all specimens examined. Surface of shell marked by strong, sharp, elevated, concentric ridges that merge into each other more or less toward the posterolateral edges of the shell, where they terminate on the margin (Pl. XXXII, fig. 5c); the space between the ridges slopes rapidly down into the rounded hollow and more gently up the anterior slope, which gives the effect of a subimbricated surface to the shell; fine radiating striæ mark the space between the ridges, and some of the better-preserved ridges are marked by faint depressed striæ; the irregularity of the ridges is most marked where they inosculate, especially toward the sides; the inner layers of the shell are marked by concentric lines of growth and fine radiating striæ, and the inner surface by both sets of striæ and numerous strong pits scattered over the surface and gathered like beads on the concentric growth lines. The shell is formed of the usual thin outer layer and numerous inner layers or lamellæ, but it is usually compressed in the shaly, impure sandstone so as to destroy the details of its lamellated character. The size and relative proportion of the valves are shown by the illustrations.

Casts of the interior of the ventral valve show a well-defined area that extends well out on the cardinal slopes; it is divided midway by a strong pedicle groove and again by a clear but not prominent flexure line; it is also marked by rather strong growth lines parallel to its base. Casts of the area of the dorsal valve show a rather strong area marked by lines of growth. The casts of the interior of the valves show (a) a trace of the visceral area of the ventral valve, (b) the position of the posterior of the main vascular sinuses in the ventral valve, and (c) a sharp median ridge and the bifurcation of the scars left by the vessels in front of the anterior lateral muscle scars in the dorsal valve anterior to the parietal line. The only traces of the muscle scars are in the dorsal valve, where the centrals and small anterior laterals are faintly shown

[a] The synonymy for this subgenus includes only those references in which the subgenus is discussed or described. To complete the record the following mere references are listed:

Obolus Matthew [1902c, pp. 94 and 95].

Obolus (*Palæobolus*) Matthew [1903, pp. 144 and 146].

in an elongated shell (Pl. XXXII, fig. 5e). The approximation in position of the main vascular trunks is an unusual feature but one that, owing to the state of preservation of the material, is not altogether satisfactorily determined.

Observation.—This is a most interesting species and it is to be regretted that better material has not been found to illustrate the interior of the valves. The outer surface at once suggests comparison with *Obolus* (*Acritis*) *antiquissimus* (Eichwald) (Pl. XIII), but that species has a strong convex form and a short visceral cavity that is peculiar to it and that caused Mickwitz [1896, p. 205] to retain *Acritis* as a subgenus. The size and position of the visceral cavity is normal for the genus. Matthew [1899, Pl. II, fig. 2e] gives a diagrammatic figure of the dorsal valve in which he places large muscle scars far forward into the valve. A careful study of his specimen shows that the vascular canal in front of the anterior lateral scars bifurcates about the center of the shell. Another specimen laterally compressed (Pl. XXXII, fig. 5e) shows the central muscle scars in about the center of the shell despite the distortion of the shell. The positions given them by Matthew [1899, Pl. II] in the broad form of the shell appear to have been decided by their position in the compressed elongated shell; the same is also true of the strong median ridge in his figure 2e.

Matthew [1899, p. 201] proposes the subgenus *Palæobolus* for this species on account of the "close approximation of the vascular trunks" on the ventral valve. This character is shown in shells elongated and compressed laterally, but even by making allowance for compression they are closer than in other forms of the genus.

The specific name is derived from Cape Breton.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**13d′**) Sandstones opposite the third waterfall in Dugald Brook, between divisions E2a and E2b; (**10p**) sandstones just below the waterfall in Division E2b; (**13l′** and **344i** [Matthew, 1903, p. 143]) sandy shales of Division E3a; and (**13n″** and **344b** [*Matthew, 1903, p. 142*])[a] *Sandy shales of Division E3d;* all in Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River, Cape Breton, Nova Scotia.

(**344c** [Matthew, 1903, p. 142]) Sandy shales of Division E3d of Matthew's Etcheminian, on Gregwa Brook, Indian River valley; (**10p″**) sandstone on the small brook on the hill between the bridge over Indian River and McPhees Brook; and (**10r**) arenaceous shales of Division C3a? of Matthew at McAdam Shore, East Bay, east of Bras d'Or Lake; all in eastern Cape Breton, Nova Scotia.

OBOLUS (PALÆOBOLUS) BRETONENSIS LENS (Matthew).

Obolus lens-primus MATTHEW, 1902, Trans. Roy. Soc. Canada for 1902, 2d ser., vol. 8, sec. 4, No. 3, pp. 94–95. (Characterized. This is the first reference to this variety.)

Obolus lens MATTHEW, 1902, idem, p. 95, Pl. I, figs. 6a–f. (Characterized.)

Obolus (*Palæobolus*) *lens* MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 144–146, Pl. X, figs. 1a–f. (Described and discussed. Figs. 1a–f are copied from figs. 6a–f, respectively, of the preceding reference.)

Obolus (*Palæobolus*) *lens longus* MATTHEW, 1903, idem, pp. 146–147, Pl. VII, figs. 4a–h. (Described and discussed as a new variety.)

Matthew [1902b, p. 95] gives a specific value to the difference in the number and closeness of the concentric striæ on the surface of the shell, but from a study of the types of *Obolus* (*Palæobolus*) *bretonensis* and material representing the surface of *O.* (*P.*) *lens* I do not think *lens* is more than a variety of *bretonensis*. The variety *longus* is based on specimens that have been compressed laterally to such an extent as to lose their original outline. With the types before me I do not feel justified in assigning them as a variety distinct from the variety *lens* with which they are associated. *O.* (*P.*) *bretonensis* occurs in beds between layers containing the variety *lens*.

Loper collected a number of specimens of a shell that may be referred to the variety *lens* in Matthew's assise 2c, in which the concentric striæ or ridges are very fine on the umbo, gradually becoming coarser toward the front, where they are of the size of the average in the typical forms of *O.* (*P.*) *bretonensis*. These shells also vary in outline so as to include the variety *longus*. In a layer just below that containing these shells he found a single shell with concentric ridges stronger and coarser than the average of *O.* (*P.*) *bretonensis*.

[a] **344b** is the type locality.

Matthew [1892, p. 94] uses the name *Obolus lens-primus* for a small shell of this species which was found in a lower layer of rock. The form is not illustrated or described in his larger work [Matthew, 1903], and I could not discover from the specimen that it was anything more than a young shell of the variety *lens*.

FORMATION AND LOCALITY.—**Middle Cambrian**: (13e) Sandstones of Division E2c; (13 1 and 344i [Matthew, 1903, p. 80]) sandy shales of Division E3a; (344 [Matthew, 1903, p. 144]) sandy shales of Division E3b; and (13n′)[a] *sandstones of Division E3e:* all in Matthew's [1903, p. 21] Etcheminiau, on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

(13m) Sandstones of Division E3f of Matthew's [1903, p. 76] Etcheminian, on Gillis Brook, Indian River, eastern Cape Breton, Nova Scotia.

FORDINIA Walcott, subgenus of OBOLUS.

Elkania Ford, WALCOTT (in part), 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 321–323. (Described and discussed; see under *Elkania*, p. 561, for copy. The text includes reference to species now placed under both *Elkania* and *Obolus* (*Fordinia*).)

Obolus (*Fordinia*) WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 64–65. (Characterized and discussed as below as a new subgenus.)

Obolus (*Fordinia*) WALCOTT, 1908, idem, No. 4, Pl. XI, and pp. 142 and 144. (Classification of subgenus.)

This subgenus of *Obolus* is proposed for species having a *Lingulella*-like outline and form with the development of a tendency to form a platform or thickening in the valves in connection with the attachment of the muscles in the ventral valve and a thickening in the posterior portion of the dorsal valve back of the central muscle scars. The type of the subgenus, *O.* (*F.*) *perfectus* Walcott (Pl. LXIII, figs. 10, 10a–d), has these characters well developed. The second species, *O.* (*F.*) *bellulus* (Walcott) (Pl. LI, figs. 3, 3a–f), has the cardinal area of the ventral valve more united with the visceral area than it is in *O.* (*F.*) *perfectus*, and the raised area in the dorsal valve is much smaller. In *O.* (*F.*) *gilberti* Walcott the thickened areas are much smaller than in the other two species. These three species represent a form intermediate between *Obolus* (Pls. VII and VIII) and *Elkania* (Pl. LI).

Type.—Obolus (*Fordinia*) *perfectus* Walcott.

The subgeneric name was given in honor of Mr. S. W. Ford.

OBOLUS (FORDINIA) BELLULUS (Walcott).

Plate LI, figures 3, 3a–f.

Elkania bellula WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 323. (Described and discussed as below as a new species.)

General form elongate oval, biconvex; beaks marginal. Surface marked by fine concentric striæ of growth that occasionally form varices and small ridges near the umbo; the inner layers or lamellæ have radiating striæ in addition to concentric striæ.

The shell is relatively thin and small. It rarely exceeds 2.5 mm. in length and a little less in width; the dorsal valve is somewhat shorter than the ventral.

Ventral valve subacuminate, moderately convex; the interior shows a reversed cardinal area attached to the bottom of the valve and below the plane of the margins of the valve; the pedicle groove is strong; the line of demarcation between the cardinal area and the bottom of the valve is indefinite, as the margin of the area and the body of the shell have been merged into each other; the transmedian and anterolateral muscle scars are outside the main vascular sinuses and near the margin of the valve; the central scars and middle and outside lateral scars are supposed to have been attached within the area (x) (Pl. LI, figs. 3a, 3b), as in *Obolus;* the area is largely on the front slope of the thickening of the umbonal portion of the valve.

The dorsal valve has a short reversed area, as shown in Plate LI, figure 3e; the anterolateral muscle scars were probably well advanced toward the front, judging from traces of the length of the visceral cavity.

[a] 13n′ is the type locality, though the specimens in the United States National Museum to which that number is assigned were collected somewhat later than Doctor Matthew's.

The vascular markings include the main vascular sinuses in the ventral valve and traces of the visceral area in the dorsal valve.

This pretty little shell is much like a small species of *Obolus* in its exterior appearance; the interior connects it with *Obolus* (*Fordinia*) *perfectus* Walcott and *O.* (*F.*) *gilberti* Walcott. I know of no species closely related to it.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**7x** and **7y**)[a] *Limestone of the Emigrant formation* [*Turner, 1902, p. 265*], *about 2.5 miles (4 km.) southeast of Emigrant Pass;* and (**7z**) limestone of the Emigrant formation [Turner, 1902, p. 265], about 3 miles (4.8 km.) southeast of Emigrant Pass; both in the Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County, Nevada.

Specimens that are somewhat doubtfully referred to *Obolus* (*Fordinia*) *bellulus* occur at the following locality:

(**54f**) 150 feet (45.7 m.) above the Middle Cambrian and 1,075 feet (327.7 m.) below the top of the Upper Cambrian in the light-gray sandstone forming No. 4 of the St. Charles formation [Walcott, 1908f, p. 193], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

OBOLUS (FORDINIA) GILBERTI Walcott.

Plate LI, figures 5, 5a–d.

Obolus (*Fordinia*) *gilberti* WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 65, Pl. VII, figs. 15 and 15a. (Discussed as below as a new species. Figs. 15 and 15a are copied in this monograph, Pl. LI, figs. 5 and 5b, respectively.)

This shell was first thought to belong with *Dicellomus politus* (Hall). It differs from that species in the character of the interior of the dorsal valve and in the narrowing of the umbo as it merges into the apex. The nearest related species is *Obolus* (*Fordinia*) *bellulus* (Walcott). It differs from the latter in being more convex and in the narrowing of the umbo toward the apex.

The average size of the ventral valve is from 4 mm. to 5 mm. in length by 3 mm. to 4 mm. in width. The dorsal valve is a little shorter than the ventral.

The generic reference is based on the interior of the dorsal valve, which is similar to that of *O.* (*F.*) *bellulus* (Walcott). Associated with this species are specimens so distinct that they are doubtfully referred to the same species.

The specific name is given in honor of Mr. G. K. Gilbert, geologist, of the United States Geological Survey.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**11n**) About 3,000 feet (914.4 m.) above the Lower Cambrian and 1,400 feet (426.7 m.) below the Upper Cambrian, in the upper part of the limestone forming 1a of the Marjum limestone [Walcott, 1908f, p. 179], in the long cliff 2 miles (3.2 km.) southeast of Marjum Pass [Walcott, 1908f, Pls. XIII and XV], House Range, Millard County, Utah.

OBOLUS (FORDINIA) PERFECTUS Walcott.

Plate LXIII, figures 10, 10a–d.

Obolus (*Fordinia*) *perfectus* WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 65–66, Pl. VII, fig. 16. (Described and discussed as below as a new species. Fig. 16 is copied in this monograph, Pl. LXIII, fig. 10a.)

General form elongate oval, biconvex; beaks marginal. Surface marked by concentric lines and striæ of growth that gather irregularly in small ridges on the anterior two-thirds of adult shells; very fine, obscure, radiating lines are preserved on some specimens of the outer surface. A shallow, narrow, median sinus occurs on each valve, on which the striæ arch slightly backward. Substance of shell apparently calcareocorneous. The shell is strong and built up of numerous layers or lamellæ that, except toward the beaks, are oblique to the outer layer.

Ventral valve broad ovate, with a rather blunt subacuminate beak; very young shells are broad oval in outline. Area short, and on the plane of the edges of the valve; it is divided midway by a narrow pedicle furrow that interrupts the transverse striæ of growth.

Dorsal valve a little shorter and more rounded at the beak; area short and marked by transverse striæ of growth. Both valves moderately convex.

[a] **7x** is the type locality.

The interior of the ventral valve shows what appears to be a short continuation of the cardinal area forward into the valve before the slope into the visceral cavity; it is as though an area with lines of growth were added to the internal area of the ventral valve of *Elkania desiderata* (Billings) (Pl. LI, fig. 1). The front margin of the area merges in *O.* (*F.*) *perfectus* into the thicker shell back of the visceral cavity, much as in *O.* (*F.*) *bellulus* (Walcott). The pedicle furrow extends forward from the posterior margin across the true area and its anterior extension to the visceral cavity. The visceral area is bordered by two ridges that diverge from the sides of the pedicle furrow and extend forward about one-third the length of the valve; these ridges widen toward the front, and where they terminate there appear to be two or three minute muscle scars corresponding to the outside and middle laterals and central scars of *Obolus;* outside of the ridge there is a furrow that was probably occupied by the main vascular canal, and beyond, two narrow, elongate spaces in which the transmedian and anterior lateral muscle scars appear to be situated; all the furrows head back against the thickened shell in front of the cardinal area; the surface of the interior of the valve is marked by concentric lines and very fine radiating striæ.

The dorsal valve (Pl. XLIII, fig. 10) has a short strong median ridge in front of the cardinal area, and well toward the center of the valve a narrow sharp median ridge; on each side of the latter where it begins posteriorly a small oval muscle scar (central h) occurs, and at its anterior end two elongate oval scars (anterior laterals j) that are larger than the centrals; on the thickened posterolateral portions of the valve, two small muscle scars (transmedian and outside and middle laterals, l and k) occur close to the outer margin. The surface of the visceral cavity is smooth, but in front of it the minute irregular vascular markings are very ornate; a few radiating striæ also occur.

The two interiors described are unusually distinct; usually the various parts and scars are more or less obscure.

This species approaches *O.* (*Fordinia*) *gilberti* Walcott more nearly than any other species of the genus. It differs in the presence of the sinus in both valves; in being less convex; in its less pointed beak; and in its strongly marked interior. It occurs over 1,000 feet higher up in the section of the Middle Cambrian limestones than *O.* (*F.*) *gilberti.* The interior of its ventral valve is somewhat like that of *O.* (*F.*) *bellulus* (Walcott) (Pl. LI, fig. 3a), but it differs from that in having a cardinal area in both valves that has not been merged into the internal cardinal area.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**30n** and **30n′**)[a] About 3,750 feet (1,143 m.) above the Lower Cambrian and 650 feet (198 m.) below the Upper Cambrian in the shaly limestones forming 1c of the Weeks limestone [Walcott, 1908f, p. 175]; and (**30o**) about 3,950 feet (1,204 m.) above the Lower Cambrian and 450 feet (137.2 m.) below the Upper Cambrian in the shaly limestones forming 1b of the Weeks limestone [Walcott, 1908f, p. 178]; both on the north side of Weeks Canyon, about 4 miles (6.4 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah.

LINGULOBOLUS Matthew,[b] subgenus of OBOLUS.

[Lingula and Obolus.]

Lingulobolus MATTHEW, 1895, Trans. Roy. Soc. Canada for 1895, 2d ser., vol. 1, pp. 260–261. (Described and discussed as a new genus.)

Sphærobolus MATTHEW, 1895, idem, p. 263. (Described and discussed as a provisional new genus.)

Obolus (*Lingulobolus*) (Matthew), WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 683. (Characterized as a subgenus.)

Obolus (*Lingulobolus*) (Matthew), WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 144. (Classification of subgenus.)

Differs from typical *Obolus* in the strongly arched and thick valves, and the surface marked by subimbricated, wavy, concentric lines and striæ of growth.

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[a] **30n** is the type locality.

[b] The synonymy for this subgenus does not give a complete record of the various genera under which the species now included in *Lingulobolus* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Lingulella? Billings [1872b, p. 468; 1874, p. 67; 1882, p. 15].
Lingulepis Walcott [1889a, p. 381].
Obolus (*Lingulobolus*) Walcott [1898b, p. 327].
Lingulobolus Grabau [1900, p. 621].
Sphærobolus Grabau [1900, p. 622].

Two species from the Lower Ordovician may be referred to *Lingulobolus*, namely, *O.* (*L.*) *affinis* and *O.* (*L.*) *spissus*.

The thickening of the shell mentioned by Matthew is a common feature in *Obolus*, and I do not find the arrangement of the muscle scars to vary materially from those of *O. apollinis*.

Type.—*Lingulella? affinis* Billings.

Obolus (Lingulobolus) affinis (Billings).

Plate XVI, figures 1, 1a–e.

Lingulella? affinis Billings, 1872, Canadian Naturalist, 2d ser., vol. 6, No. 4, p. 468; fig. 4, p. 467. (Described.)

Lingulella? affinis Billings, 1874, Geol. Survey Canada, Paleozoic Fossils, vol. 2, pt. 1, p. 67, fig. 35, p. 66. (Described. Fig. 35 is copied from fig. 4 of the preceding reference.)

Lingulella affinis Billings, 1882, Geol. Survey Newfoundland, Rept. Progress for 1881, Appendix, pp. 15–16. (Copied from preceding reference.)

Lingulepis affinis (Billings), Walcott, 1889, Am. Jour. Sci., 3d ser., vol. 37, p. 381. (Mentioned under new generic name.)

Lingulobolus affinis (Billings), Matthew, 1895, Trans. Roy. Soc. Canada for 1895, 2d ser., vol. 1, sec. 4, No. 13, pp. 261–262, Pl. I, figs. 4a–b. (Original description, Billings, 1872b, p. 468, copied and species described and discussed.)

Lingulobolus affinis cuneata Matthew, 1895, idem, p. 262, Pl. I, figs. 4c and 4d. (Described and discussed. This is the first reference to this variety.)

Obolus (*Lingulobolus*) *affinis* (Billings), Walcott, 1898, Am. Jour. Sci., 4th ser., vol. 6, p. 327. (New locality mentioned.)

Lingulobolus affinis (Billings), Grabau, 1900, Occas. Papers Boston Soc. Nat. Hist., No. 4, vol. 1, pt. 3, pp. 621–622. (Described.)

General form subtriangular, with the ventral valve subacuminate and the dorsal valve slightly rounded at the beak. There is a little variation in the outline of the valves, some being slightly longer in proportion to the width. The valves are strongly convex, the dorsal being the most so. A dorsal valve 30 mm. in length has a convexity of 5 mm.; a ventral valve of the same length has a convexity of 4 mm. above the plane of the margin.

The surface of the shell is marked by fine radiating striæ and concentric lines of growth, and very fine, concentric, slightly undulating, imbricating striæ; when the outer surface of the shell is exfoliated the surface of the inner layers shows rounded, radiating striæ crossed by the concentric lines of growth, and fine, slightly irregular, concentric striæ. The interior surface over the visceral cavity is marked by minute pits or punctæ that in the anterior portion of the shell are arranged in concentric lines, giving a highly ornamental appearance to the shell when examined by a strong lens.

The shell is thick, being built up of a thin outer layer and numerous inner layers or lamellæ that are oblique to the outer surface over the anterior and lateral portions of the shell. There is a strong development of the inner layers of the shell over the visceral area, the impressions of the muscle scars and vascular markings showing on the various layers as though there had been a rapid deposit of shell substance beneath those parts. Usually the direct point of attachment of the muscle is deeply impressed in the shell substance, but not always so.

The longest ventral valve in the collection has a length of 30 mm.; width, 25 mm. A large dorsal valve has a length of 32 mm. and a width of 29 mm.

The interior casts show that the area of the ventral valve is not very clearly defined; it is rather long and divided midway by a cast of a rather narrow pedicle groove; it is very rarely that any traces of the area can be observed. The area of the ventral valve is obscure in most specimens; one example shows that it forms a shelf, the undercut projecting slightly beneath it so as to form in the cast two rounded projections extending toward the beak, on each side of the median line, giving very much the same appearance as the same parts in the dorsal valve of *Lingulella granvillensis* (Walcott) (Pl. XXII, fig. 1d).

The cast of the visceral cavity of the ventral valve is very much like that of *Obolus matinalis* (Hall) and *Obolus* (*Westonia*) *rogersi* (Walcott). The material is somewhat imperfect, but there is an outline of the heart-shaped cavity (x), and the position of the space including the central, middle lateral, and outside lateral muscle scars is indicated (Pl. XXII, figs. 1, 1b).

The muscle scars are not so well shown in this species as in the associated *Obolus* (*Lingulobolus*) *spissus*. In the ventral valve the anterior lateral and transmedian scars are so closely united with each other that they can not be differentiated. It is the same with the centrals, which appear to be crowded in with the middle and outside laterals. In the dorsal valve the central and anterior lateral muscle scars are clearly defined, and the position of the transmedian and the outside and middle laterals is fairly well shown in one specimen. The markings left on the shell by the vascular system are confined to the main or trunk sinuses, which are imperfectly represented.

Observations.—Billings [1872b, fig. 4] illustrated an elongate form of the ventral valve, and Matthew [1895b, Pl. I] a shorter ventral valve, and with it, as the dorsal valve, the dorsal valve of *O.* (*L.*) *spissus*. The form that Matthew [1895b, p. 262] has described as the variety *cuneata* is probably a dorsal valve of *O.* (*L.*) *affinis*.

This is one of the largest shells that has been referred either to *Obolus* or its subgenera. In form it resembles other cuneate species, but it differs from all in the thickness of the shell and the slight definition of the cardinal areas of the valves. It is quite probable that if we had a series representing the stages of growth the young shells would be referred to *Lingulella*, as *Lingulobolus* to me appears to be an extravagant development of a species of *Lingulella* that has had unusually favorable conditions for growth. *Obolus* (*Lingulobolus*) *affinis* is associated with *O.* (*L.*) *spissus* (Billings) and *Obolus* (*Westonia*) *rogersi* (Walcott).

Formation and locality.—**Lower Ordovician: (114b)**[a] *Sandstone 1 mile (1.6 km.) north of Lance Cove, Great Belle Island, Conception Bay, Newfoundland.*

(**326a** [Grabau, 1900, p. 613]) Limestone pebbles in a Carboniferous conglomerate north of Fall River, Bristol County, Massachusetts.

Obolus (Lingulobolus) spissus (Billings).

Plate XVI, figures 2, 2a–k; Plate XLII, figures 3, 3a.

Lingulella? spissa Billings, 1872, Canadian Naturalist, 2d ser., vol. 6, no. 4, pp. 468–469, figs. 5a–c, p. 467. (Described.)

Lingulella? spissa Billings, 1874, Geol. Survey Canada, Paleozoic Fossils, vol. 2, pt. 1, pp. 67–68, figs. 36a–c, p. 66. (Described. Figs. 36a–c are copied from figs. 5a–c, respectively, of the preceding reference.)

Lingulella? spissa Billings, 1882, Geol. Survey Newfoundland, Rept. Progress for 1881, Appendix, p. 15, Pl. III, figs. 12a–c. (Text and figures copied from preceding reference.)

Sphærobolus spissus (Billings), Matthew, 1895, Trans. Roy. Soc. Canada, 2d ser., vol. 1, pp. 263–266, Pl. I, figs. 5a–c. (Original description [Billings, 1872b, pp. 468–469] copied and species described and discussed.)

Obolus (*Lingulobolus*) *spissus* (Billings), Walcott, 1898, Am. Jour. Sci., 4th ser., vol. 6, p. 327. (New locality mentioned.)

Sphærobolus spissus (Billings), Grabau, 1900, Occas. Papers Boston Soc. Nat. Hist., No. 4, vol. 1, pt. 3, pp. 622–623. (Described.)

General form ovate, with the ventral valve broadly subacuminate and the dorsal valve obtusely rounded; valves strongly convex, the dorsal being about one-third more so than the ventral. The proportions of the convexity are shown by the outlines accompanying the figures. The surface of the shell is marked by concentric lines of growth and very fine undulating, subimbricated, concentric striæ and very fine radiating striæ, which, crossing the fine concentric striæ, cut the surface up into minute squares or parallelograms. This type of surface ornamentation also occurs on one or two of the inner layers of the shell just beneath the outer layer. The surface of the inner layers, especially that of the lamellæ forming the anterior lateral thickenings of the shell, is marked by numerous flattened striæ and over the central portions by raised, threadlike striæ; the interior of the shell and some of the interior layers are marked by fine pits or punctæ, arranged in more or less concentric lines. In addition, there is a finely punctate surface that can be seen only with the aid of a high magnifying power.

The shell is formed of a thin outer layer and numerous inner layers or lamellæ, the latter, as oblique lamellæ, becoming more numerous over the anterior and lateral portions of the

[a] **114b** is the type locality, though the specimens in the United States National Museum to which that number is assigned were collected much later than the type specimens.

shell. Over the central portion of a ventral valve 13 distinct layers may be counted, and at the anterior edge of the same shell 15 of the oblique lamellæ that are strongly marked by the radiating striæ. The valves vary somewhat in size, outline, and degree of convexity. An unusually acuminate ventral valve has a length of 20 mm. and a width of 19 mm. A dorsal valve 15 mm. in length has a width of 16 mm.

Casts of the interior of the ventral valve show a rather narrow area and a strong pedicle furrow which is broad at the base. The striæ of growth on the area are arranged in an imbricated manner, very much as on the area of *Obolus prindlei* (Walcott). The area of the dorsal valve is narrow and almost concealed beneath the slightly overarching posterior margin.

The cast of the ventral valve (v) shows roughly the heart-shaped cavity (x) of *Obolus* (Pl. XVI, fig. 2k). There are no traces of a median septum in the ventral valve; in the dorsal valve the septum extends as a low ridge with a sharp crest between the central muscle scars and forward, so as to divide the anterior lateral scars.

The muscle scars are finely shown in both valves. The umbonal scar of the ventral valve is divided, as in *Obolus*, the pedicle scar being situated between the two parts. In the dorsal valve the umbonal scar is very close to the area and arches slightly backward. The scars of the central muscles are not clearly defined in the ventral valve, owing to their being crowded in with the scars of the central and outside laterals. Their position, judging from the location of the centrals in *Obolus*, is within the transversely trapezoidal area (c), indicated in Plate XVI, figure 2j. On the dorsal valve the centrals are large and distinctly defined on many casts of the interior of the shell and on partly exfoliated specimens. They are situated near the center or sometimes a short distance in advance of the center of the shell, on either side of the median ridge; they are oval in outline, the longer axis diverging slightly outward anteriorly. The anterior laterals (j) are clearly defined in both valves. In the ventral valve they are very close to the transmedian, if not actually in contact with them (Pl. XVI, fig. 2k); in the dorsal they are small and situated on either side of the median ridge a short distance in advance of the central scars (Pl. XVI, fig. 2h). The middle and outside lateral scars on the ventral valve are situated in the trapezoidal area (c), but neither is clearly separable in any specimen of the collection, unless it be in that represented by Plate XVI, figure 2k, where the outside lateral scars (l) and the middle lateral scars (k) may be present. In the dorsal valve of *Obolus*, the middle (k) and the outside (l) laterals are closely united, and they are apparently combined in an elongate scar at (l) (Pl. XVI, figs. 2a and 2g). This scar corresponds in position with the two sears in *Obolus* and it is deeply impressed in the thick shell of this species, much more so than the large central scars, which apparently were but slightly impressed or else were situated upon elevations on the inner surface of the shell. Some specimens show the elevation and others the depression for the same set of scars. The transmedian scars (i) are not so distinctly shown on most of the specimens of the dorsal valve, as they appear to have been lost in connection with the deep depression formed by the outside and middle laterals. In one specimen, however, (Pl. XVI, fig. 2a) they are fairly well defined. In the ventral valve they are closely united with the anterior laterals (j), but can be distinguished from them.

The markings left on the shell by the vascular system are well preserved in a few casts of the interior of the valve. The main or trunk sinuses are strong and curved inward a short distance in front of the visceral cavity. Numerous fine peripheral branches radiate toward the margin and a few short lateral branches toward the visceral cavity. In a dorsal valve the main sinuses curve in front of the visceral cavity, very much as in the ventral valve. The interior lateral sinuses radiate from the main sinus in toward the visceral cavity, and the peripheral branches extend upward toward the margins. In some specimens where the projections of the visceral cavity back of the central muscle scars unite with the main sinus there is an apparent broadening of the sinus that produces a rather sharp angle opposite the central scars. In the ventral valve the depressed space in front of the visceral cavity is marked by narrow, radiating, and longitudinal spaces, which apparently were occupied by the anterior portion of the viscera, as the narrow canals unite toward the heart-shaped cavity and the

areas occupied by the muscle scars (Pl. XVI, fig. 2j). This latter character is probably what Mickwitz [1896, p. 69] describes as the longitudinal striation of the area in advance of the visceral cavity in *Obolus*. The parietal scar is distinctly shown in advance of the visceral area of the dorsal valve, where its course may be followed from the median line in front of the anterior lateral muscle scars to the outward curve to the main vascular sinuses, beyond which it has not been observed. In none of the specimens of the ventral valve can the exact position of the parietal scar be determined.

Observations.—The study of the material which I collected at the typical locality in 1888 shows clearly that this species is very closely related to *Obolus*. It differs in having a smaller area and somewhat in the form and convexity of the valves. There are no special characters that do not apparently fall well within the limits of *Obolus*. There is certainly not more than a subgeneric difference between the different forms of *Obolus* and *Obolus* (*Lingulobolus*) *spissus*.

Billings [1872b, p. 467] figured a ventral and a dorsal valve, but furnished a very inadequate illustration and description. Matthew [1895b, Pl. I] illustrated what appear to be two dorsal valves, one somewhat more elongate than the other. With a large series of specimens I am unable to find any ventral valve which shows the characters illustrated by Matthew in his figure 5a [1895b, Pl. I]. On the contrary, most of them are to be observed in specimens of the dorsal valve.

FORMATION AND LOCALITY.—**Lower Ordovician:** (**114b**)[a] *Sandstone 1 mile (1.6 km.) north of Lance Cove, Great Belle Island, Conception Bay, Newfoundland.*

(**326a** [Grabau, 1900, p. 613]) Limestone pebbles in a Carboniferous conglomerate north of Fall River, Bristol County, Massachusetts.

MICKWITZELLA Walcott,[b] subgenus of OBOLUS.

Aulonotreta KUTORGA (in part), 1848, Verhandl. Russ.-kais. min. Gesell. St. Petersburg for 1847, No. 12, pp. 278–279. (Described and discussed in German as a new genus. The species referred to the genus belong with *Obolus*, *Obolus* (*Acritis*), and *Obolus* (*Mickwitzella*).)

Obolus Eichwald, DAVIDSON (in part), 1853, British Fossil Brachiopoda, vol. 1, introduction, No. 3, pp. 135–136. (Described and discussed. As far as they have been identified in this monograph the species referred to the genus belong with *Obolus*, *Obolus* (*Acritis*), and *Obolus* (*Mickwitzella*).)

Not *Thysanota* ALBERS, 1860, p. 63. (Proposed for a genus of the Gastropoda; see Marshall's Nomenclator Zoologicus, p. 142.)

Obolus EICHWALD (in part), 1860, Lethæa rossica, ancienne période, vol. 1, sec. 2, pp. 924–925. (Described in French. The species referred to the genus belong with *Obolus*, *Obolus* (*Acritis*), and *Obolus* (*Mickwitzella*).)

Obolus (*Thysanotos*) MICKWITZ, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 194–195. (Characterized in German as a new subgenus. See below for translation.)

Obolus (*Thysanotus*) Mickwitz, WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 683. (Characterized.)

Obolus (*Mickwitzella*) WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 70. (Copies the original description of Mickwitz, as below.)

Obolus (*Mickwitzella*) WALCOTT, 1908, idem, vol. 53, No. 4, Pl. XI, and pp. 142 and 144. (Classification of genus.)

The original description by Mickwitz follows:

The subgenus *Thysanotos*, containing a single species, *O. siluricus* Eichwald, differs from the Cambrian subgenera *Euobolus* and *Schmidtia* mainly by the fringed anterior border of the growth lamellæ of its valves, and by the concentric striation arranged parallel to the posterior edge of these lamellæ—two features that point to a peculiar organization of the edge of the mantle. The last-mentioned peculiarity appears also in the subgenus *Acritis*.

Type.—Obolus siluricus Eichwald.

The subgeneric name was given in honor of the late Dr. A. Mickwitz, of Reval, Esthonia.

OBOLUS (MICKWITZELLA) SILURICUS (Eichwald).

Plate XV, figures 1, 1a–c.

Obolus siluricus EICHWALD, 1843, Beiträge zur Kenntniss des russischen Reiches, Bd. 8, No. 2, pp. 7–8, Pl. I, figs. 15a–c. (Described and discussed in German as a new species.)

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[a] **114b** is the type locality, though the specimens in the United States National Museum to which that number is assigned were collected much later than the type specimens.

[b] The synonymy for this subgenus does not give a complete record of the various genera under which the species now included in *Mickwitzella* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Obolus Eichwald [1843, p. 7].
Obolus de Verneuil [1845, p. 290].
Obolus Eichwald [1859, Pl. XXXVII, figs. 6 and 7].
Obolus Schmidt [1861, p. 218; 1881, p. 17].
Lingula Schmidt [1881, p. 17].
Obolus Mickwitz [1892, p. 60].

Obolus apollinis Eichwald, DE VERNEUIL (in part), 1845, Géologie de la Russie d'Europe, by Murchison, de Verneuil, and de Keyserling, vol. 2, pt. 3, pp. 290–292. (Described and discussed in French. The reference includes *Obolus* (*Mickwitzella*) *siluricus*, *Obolus* (*Acritis*) *antiquissimus*, *Obolus apollinis*, and *Obolus apollinis ingricus*; *Obolus apollinis* being figured.)

Aulonotreta polita KUTORGA (in part), 1848, Verhandl. Russ.-kais. min. Gesell. St. Petersburg for 1847, No. 12, pp. 279–282 (not Pl. VII, figs. 10a–f). (Described and discussed in German as a new species. The text includes *Obolus* (*Mickwitzella*) *siluricus*, *Obolus apollinis ingricus*, and *Obolus apollinis*, the last species being figured.)

Obolus siluricus EICHWALD, 1859, Lethæa rossica, ancienne période, Atlas, Pl. XXXVII, figs. 6 and 7a–b. (The text reference accompanying these figures is in the following citation.)

Obolus siluricus EICHWALD, 1860, Lethæa rossica, ancienne période, vol. 1, sec. 2, pp. 927–928. (Described and discussed in French.)

Obolus siluricus Eichwald, SCHMIDT, 1861, Archiv für Naturkunde Liv-, Ehst-, und Kurlands, 1st ser., vol. 2, p. 218. (Mentioned in German.)

Obolus siluricus Eichwald, SCHMIDT, 1881, Mém. Acad. Imp. Sci. St.-Pétersbourg, 7th ser., vol. 30, No. 1, p. 17. (Locality mentioned in German.)

Lingula cf. *davisi* Salter, SCHMIDT, 1881, idem, fig. 5, p. 17. (Mentioned in the text.)

Obolus siluricus Eichwald, MICKWITZ, 1892, Mélanges géol. et paléontol. tirés du Bull. Acad. imp. sci. St.-Pétersbourg, vol. 1, p. 60. (Mentioned in German.)

Obolus (*Thysanotos*) *siluricus* (Eichwald), MICKWITZ, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 195–199, Pl. III, figs. 1–9. (Described and discussed in German; see below for translation. Fig. 9 is copied in this monograph, Pl. XV, fig. 1b.)

Mickwitz [1896, pp. 195–199] describes the species as follows:

Shells large, very flatly arched, thin, brittle. Outline of shells round, somewhat broadened. Posterior borders of shells rectilinear, not winged. Tip of the beak of large shell slightly curved inwardly. Surface of shell very lustrous, like varnish. Concentric striæ in sharp-edged ribs, which are separated by flat troughs. These ribs run parallel to the posterior borders of the growth lamellæ and therefore always become shorter toward the anterior borders of the same. Growth lamellæ prettily fringed at the anterior borders; the concentric striæ are continued on the fringes. Area large, quite smoothly striate, slightly excavated at the base of the splanchnocœlic part. Pleurocœlic part of the area extends far into the lateral borders of the shell. Traces of the pseudo-area lamellæ approach the borders of the peduncular groove, and converge into the tip of the beak. Peduncular groove large, deep, roundly hollowed, inwardly strongly broadened. Thickening of the shells very slight. Central groove of the large shell indefinitely flat. Corneous processes and sinus of the small shell strongly receding. Median swelling of the small shell broad and flat, divided at its anterior half by a broad median groove. Principal vascular traces broad and flat, separated by a median swelling into two sharp-cut furrows. Places of attachment of the central muscles of the small shell large, circular; those of the umbonal muscles very coarsely longitudinally striate.

Observations: The large shell of this species reminds one in form of *O. apollinis quenstedti*, especially of a specimen whose relative numbers also somewhat correspond with those of *O. siluricus*. In comparing these numbers, one must take into consideration that the only large shell of the last-mentioned species, which allowed measurement, is somewhat pressed in from above, so that the heights given in the table of measures may most likely be somewhat too small. The small shell, however, has a somewhat broader form than the corresponding Cambrian species, and varies in outline by having the greatest breadth nearer the anterior border.

The exterior surface of the shell of *O. siluricus* has already been spoken of on several occasions: The crescent-shaped growth lamellæ, which correspond to a vegetative period, run out as in all *Obolus* shells into the posterior borders of the shell, which, so to say, inclose them. The law of growth of the growth lamellæ, or the seam of the mantle which produces the same, is plainly here and there the same. Now the aberrancy of this species consists in the fact that the concentric striæ of these lamellæ do not converge into the tip of the crescent as the other species—with the exception of *O. antiquissimus*—but run parallel to the posterior (interior) border of the lamellæ and therefore always become shorter toward the anterior. It is self-evident that this aberrant plaited formation must have corresponded to an aberrant character of the seam of the mantle, but what the character of the latter was is unknown. Also the profile of the concentric striation of *O. siluricus* deviates essentially from the other ornamented species of Eichwald's genus; for example, *O. triangularis* shows a regular wavy line in which the crests and troughs of the wave are composed of equal curves. In *O. siluricus*, however, the curves of the troughs follow immediately on one another, so that the crests run out into sharp points. *O. antiquissimus*, which has an intermediate form, shows the crests of the waves somewhat rounded off at the point.

The fringes, with which the growth lamellæ are ornamented at the close of the vegetative period, correspond with the radial striation on the interior side of the appertaining lamellæ in such a manner that every notch between two teeth of fringes is equal to a radial furrow. These radial furrows, which owe their formation to the setæ, which are sunk into the seam of the mantle, are peculiar to all Oboli and were already observed in the impression by Eichwald in all shells whose upper layer (growth lamella) was broken off. To every notch of the fringe therefore corresponds a seta of the mantle. The subject can not be followed any further. We also here meet with the peculiar but unknown character of the seam of the mantle, which produces a pretty fringe in the vegetative rest; in the period of growth, however, it produces a lamella which is interrupted at the border, both being furnished with concentric ribs. The teeth of the

fringes, at the anterior border of the adult shell, reach a considerable length (four to five transverse ribs); near the beak they are only indicated.

The breadth of the growth lamellæ of this species varies greatly. One shows in the center of the shell a width of 5.5 mm., while the center lamella of another is only 2 mm. broad. This is plainly connected with the relative conditions of nourishment. Independent thereof also here, as with all *Obolus* species, a diminishing of the breadth of the lamellæ toward the anterior border of the adult shell takes place.

The shells of *O. silurieus* are very thin, and consequently the development of the inner characters is very slightly pronounced. In striking contrast to this peculiarity stands the strongly developed area with the broad, deeply hollowed peduncular groove, which somewhat diminishes toward the beak.

The surface of the area is smooth at the posterior part, and gives rise to the conjecture that in consequence of a narrow closing of the shell a mutual attrition has taken place. (Similarly as in *O. antiquissimus*, only in a less degree.) The same conclusion is forced upon one by the deeply hollowed peduncular groove, which allowed, even with the narrow closing of the shell, sufficient space for the passing of the peduncle; and lastly, the strongly developed longitudinally striate places of attachment of the umbonal muscle. A small shell of a young specimen also shows this place of attachment distinctly but lacks the striation in the figure.

The beak of the small shell also has in its youth a rectilinear bordered tip. In age this is somewhat worn off, so that the beak has a round appearance. The area of the small shell is hollowed transversely to the median line and therefore not exposed to attrition, which is limited to the borders of this shell. Unfortunately this part is only at hand in the already mentioned young specimen.

The inner characters of *O. silurieus* are more withdrawn from observation. On the one hand they are, as already mentioned, very slightly developed; on the other hand sufficient material is lacking. The central groove of the large shell is very flat and indefinitely bordered, but is perceptible in both figured specimens.

The principal vascular furrows are more distinctly distinguishable, their central swellings are strongly developed and rear themselves from the deeply hollowed lateral furrows. In one specimen the secondary vascular traces may be followed under a magnifying glass. The accessory vessels, radiating inwardly and perpendicularly to the principal vessels, run rectilinearly to the anterior border, and bend off shortly before reaching the median line, as has been demonstrated in other species. A shortly branched ramification of the first part of these vessels was only suggestively perceptible. The outwardly directed accessory vessels run in the known manner. Their opening into the peripheral canal is not perceptible on account of corrosion of this part of the shell.

Of the remaining visible characters in the figured large shell only the places of attachment of the combined central muscles are to be mentioned, which, however, can not be analyzed into their elements on account of the deficient preservation of the shell. In their totality, they form a narrow band, which lies before the central groove and is bordered by the parietal band. This band curves, close to the inner lateral furrows of the principal vessels, rectangularly toward the back and is widened there considerably. This portion, however, is corroded, so that the exact form of the place of attachment can not be ascertained.

In the small shell, apart from the already mentioned place of attachment of the umbonal muscle, the large circular places of attachment of the central muscles may be seen for the first time, and lie near the center of the fragment of the shell on both sides of the flat median swelling, which is divided by a broad median furrow. The places of attachment of the anterior lateral muscles are also perceptible, but only suggestively. They already lie in the scaled-off part of the anterior half of the shell. On the left above, the elongate, quite deeply sunk place of attachment of the transmedian muscle is also perceptible. Lastly, the beginnings of the principal vascular traces and parietal band, as far as the inner surface of the shell is intact, may be followed and are also expressed in the figure.

The species owes its specific name to the "Silurian" age of the beds in which it is found.

FORMATION AND LOCALITY.[a]—Passage beds between the Upper Cambrian and the Ordovician: "Glauconite sandstone" at the following localities: (**396**) At Baltischport, 30 miles (48 km.) west of Reval; (**396a**) *at Leppiko, near Leetz, on the eastern side of the Baltischport Peninsula, about 25 miles (40.3 km.) west of Reval;* (**396b**) at Fall, 15 miles (24 km.) west of Reval; (**396c**) at the mouth of Fähna Brook, east of Fall, about 15 miles (24 km.) west of Reval; and (**396e**) in the eastern part of the east Baltic region; all [Mickwitz, 1896, p. 198] in the Government of Esthonia, Russia.

(**395x** [Lamansky, 1901, p. 617]) Glauconitic sandstone (correlated by Lamansky with the Upper Cambrian *Ceratopyge* slate) in the vicinity of Baltischport, 30 miles (48 km.) west of Reval; (**395v** [Eichwald, 1843, p. 147]) sandstone on Odensholm Island, about 55 miles (88.6 km.) west of Reval; (**396y** [Eichwald, 1843, p. 147]) chlorite-bearing sands in the limestone beds at Reval; (**336f** [Eichwald, 1860, p. 927]) pyroxene-bearing sands in the *Orthoceratite* limestone beds at Reval; (**337i** [Schmidt, 1861, p. 218]) green sand at Baltischport; and (**396x** [Eichwald, 1843, p. 146]) chlorite-bearing sands in the limestone beds at Baltischport, about 30 miles (48 km.) west of Reval; all in the Government of Esthonia, Russia.

(**395w** [Eichwald, 1843, p. 147]) Chlorite-bearing sands in the limestone beds at Pawlowsk; and (**395y** [Kutorga, 1848, p. 281]) sandstone on Pulkowa Brook; both near St. Petersburg, Russia.

(**368a** [Siemiradzki, 1886, p. 672]) Gray sandstone of unknown stratigraphic position or age, in the Polnischen Mittelgebirge, north of Sandomierz on the Vistula, Russian Poland.

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[a] Localities **396** and **396a** are represented in the collections of the United States National Museum.

ACRITIS Volborth,[a] subgenus of OBOLUS.

[ἄκριτος, indiscernible.]

Aulonotreta Kutorga (in part), 1848, Verhandl. Russ.-kais. min. Gesell. St. Petersburg for 1847, No. 12, pp. 278–279. (Described and discussed in German as a new genus. The species referred to the genus belong with *Obolus*, *Obolus* (*Acritis*), and *Obolus* (*Mickwitzella*).)

Aulonotreta Kutorga, Morris, 1849, Annals and Mag. Nat. Hist., 2d ser., vol. 4, pp. 316–317. (Characterized and discussed as a synonym of *Obolus*.)

Obolus Eichwald, Davidson (in part), 1853, British Fossil Brachiopoda, vol. 1, introduction, No. 3, pp. 135–136. (Described and discussed. As far as they have been identified in this monograph the species referred to the genus belong with *Obolus*, *Obolus* (*Acritis*), and *Obolus* (*Mickwitzella*).)

Obolus Eichwald (in part), 1860, Lethæa rossica, ancienne période, vol. 1, sec. 2, pp. 924–925. (Described in French. The species referred to the genus belong with *Obolus*, *Obolus* (*Acritis*), and *Obolus* (*Mickwitzella*).)

Acritis Volborth, 1869, Verhandl. Russ.-kais. min. Gesell. St. Petersburg, 2d ser., Bd. 4, pp. 212–217. (The description and discussion of the genus (in German) is incorporated with that of *Obolus* (*Acritis*) *antiquissimus*.)

Acritis Volborth, Dall, 1877, Bull. U. S. Nat. Mus. No. 8, p. 11. (Placed as a synonym of *Aulonotreta*.)

Aulonotreta Kutorga, Dall, 1877, idem, p. 16. (Priority of this generic name over *Acritis* discussed.)

Acritis Volborth, Oehlert, 1887, Manuel de conchyliologie, by Fischer, p. 1264. (Described in French.)

Aulonotreta Kutorga, Hall and Clarke (in part), 1892, Eleventh Ann. Rept. State Geologist New York for 1891, pp. 243–244. (Described and discussed. As discussed the genus includes species referred to both *Obolus* and *Obolus* (*Acritis*).)

Aulonotreta Kutorga, Hall and Clarke (in part), 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, pp. 559–560. (Copy of preceding reference.)

Aulonotreta Kutorga, Hall and Clarke (in part), 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 82. (Described and discussed and priority, etc., of generic references discussed. As discussed, the genus includes species referred to both *Obolus* and *Obolus* (*Acritis*).)

Obolus (*Acritis*) (Volborth), Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 205–206. (Characterized and discussed in German as a subgenus; see below for translation.)

Obolus (*Acritis*) (Volborth), Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 683. (Characterized.)

Obolus (*Acritis*) Volborth, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 144. (Classification of subgenus.)

Mickwitz describes the subgenus as follows:

The subgenus *Acritis*, like the two preceding subgenera, *Thysanotos* (=*Mickwitzella*) and *Leptembolon*, is based on a single species, *Obolus antiquissimus* Eichwald, which, out of all the species of Eichwald's genus, departs most widely from the typical species.

The most prominent characteristics of this subgenus—apart from the parallelism of the concentric striation of the surface of the shell, which it has in common with the subgenus *Thysanotos* (=*Mickwitzella*)—consist in the remarkable shortening of the splanchnocœle, which even in the adult stage of the animal advances but little toward the frontal edge, and in the different arrangement of the deposit of the thickened lamellæ, which impart to the adult shells a totally different appearance.

The failure to recognize these facts was the main cause of the long controversy over the genus of *O. antiquissimus*, which after all threw no light on the subject.

Type.—Obolus (*Lucina*) *antiquissimus* Eichwald [1843, p. 142].

Obolus (Acritis) antiquissimus (Eichwald).

Plate XIII, figure 3; Plate XV, figures 2, 2a–d.

Obolus (*Lucina*) *antiquissimus* Eichwald, 1843, Beiträge zur Kenntniss des russischen Reiches, Bd. 8, No. 2, pp. 142–144, Pl. IV, figs. 1a–c. (Described and discussed in German as a new species.)

Obolus apollinis Eichwald, de Verneuil (in part), 1845, Géologie de la Russie d'Europe, by Murchison, de Verneuil, and de Keyserling, vol. 2, pt. 3, pp. 290–292. (Described and discussed in French. The reference includes *Obolus* (*Mickwitzella*) *siluricus*, *Obolus* (*Acritis*) *antiquissimus*, *Obolus apollinis*, and *Obolus apollinis ingricus*, *Obolus apollinis* being figured.)

Aulonotreta sculpta Kutorga, 1848, Verhandl. Russ.-kais. min. Gesell. St. Petersburg for 1847, No. 12, pp. 282–283 Pl. VII, figs. 11a–d. (Described and discussed in German as a new species.)

Obolus apollinis Eichwald, Davidson (in part), 1853, British Fossil Brachiopoda, vol. 1, Introduction, No. 3, Pl. IX, fig. 285 (not figs. 280–284, which represent *Obolus apollinis*). (No text reference. Fig. 285 is copied from Kutorga's figure, 1848, Pl. VII, fig. 11b, of *Aulonotreta sculpta*.)

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[a] The synonymy for this subgenus does not give a complete record of the various genera under which the species now included in *Acritis* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record, the following mere generic references are listed:

Obolus (*Lucina*) Eichwald [1843, p. 142].
Obolus de Verneuil [1845, p. 290].
Obolus Eichwald [1859, Pl. XXXVII, figs. 5a–d].
Obolus Siemiradzki [1886, p. 672].
Acritis Gagel [1890, p. 22].
Acritis Hall and Clarke [1892, p. 82].

Obolus antiquissimus Eichwald, 1859, Lethæa rossica, ancienne période, Atlas, Pl. XXXVII, figs. 5a–d. (The accompanying text is cited in the following reference.)

Obolus antiquissimus Eichwald, 1860, Lethæa rossica, ancienne période, vol. 1, sec. 2, pp. 928–929. (Described and discussed in French.)

Acritis antiquissima Volborth, 1869, Verhandl. Russ.-kais. min. Gesell. St. Petersburg, 2d ser., Bd. 4, pp. 212–217, Pl. XVII, figs. 7–9. (Described and discussed in German, the description of the genus *Acritis* being incorporated with that of the species.)

Aulonotreta sculpta Kutorga, Dall, 1877, Bull. U. S. Nat. Mus. No. 8, p. 16. (Discusses the priority of the generic names proposed for this form.)

Obolus siluricus (Eichwald), Siemiradzki, 1886, Jahrb. K.-k. geol. Reichsanstalt for 1886, Bd. 36, Hft. 4, p. 672. (Characterized and new locality mentioned.)

Acritis antiquissima (Eichwald), Gagel, 1890, Beitr. zur Naturkunde Preussens, von Physikal.-oekonom. Gesell. Königsberg, 6, p. 22, Pl. I, fig. 1. (Described in German.)

Aulonotreta antiquissima (Eichwald), Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, figs. 246 and 247, p. 244. (No text reference. Figs. 246 and 247 are copied from Volborth, 1869, Pl. XVII, figs. 7 and 9, respectively.)

Aulonotreta antiquissima (Eichwald), Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, figs. 246 and 247, p. 560. (No text reference. The figures are copied from the preceding reference.)

Acritis antiquissima (Eichwald), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 82, figs. 35 and 36. (Species discussed, and priority, etc., of generic references discussed. Figs. 35 and 36 are copied from Volborth, 1869, Pl. XVII, figs. 7 and 9, respectively.)

Obolus (*Acritis*) *antiquissimus* (Eichwald), Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 206–213, Pl. III, figs. 20–22, 24–29. (Described and discussed in German; see below for translation. Figs. 20a–b are copied in this monograph, Pl. XV, fig. 2d.)

Obolus (*Acritis*) *antiquissimus ventrosus* Mickwitz, 1896, idem, pp. 213–214, Pl. III, figs. 23a–b. (Characterized in German as a new variety.)

Mickwitz [1896, pp. 206–213] describes this species as follows:

Shells large, strongly arched. Arching of the large shell slighter than that of the smaller. Greatest height of both shells more toward the beak. Outline of shell broadly oval to round, broader than long, the greatest width lying more to the anterior border. Beak of the large shell very blunt, laterally rounded; extreme tip of the beak of the large shell lapping hook-shaped over the rectilinearly worn-off tip of the beak of the small shell. Growth lamellæ very thick, loosely disposed, their anterior sharp-edged borders projecting like a molding on their inner surfaces, strongly radially ribbed. Concentric striæ of the outer surface of the shell in wavy roundish ribs, which run parallel to the posterior border of the crescent-shaped growth lamellæ, growing constantly shorter toward the anterior border of the same. Anterior and lateral borders sharp-edged, lying in one plane with the worn-off borders of the beak. Posterior borders of the shell massive, broad, projecting inwardly in shape of a border. Area of both shells strongly developed, broadly ribbon-shaped, prolonged far into the lateral borders, deeply hollowed, polished on the surface by mutual attrition. Peduncular groove strongly conical, deeply sunk, inwardly often broadened like a trumpet, traces of the pseudo-area rectilinear, converging into the tip of the beak, attaining to distinctness as a line of the markation of the narrow splanchnocœlic and the broad pleurocœlic heads of the layers of the worn area lamellæ. Thickening of the shell extended chiefly to the brachiocœle, advancing in scalariformed terraces which follow the contours of the parietal band; with the large shell forming a thick mass in front of the central groove, and with the small filling out the lateral angular seams which penetrate into the splanchnocœle.

Splanchnocœle small, crowded back strongly to the beak, reaching under the rimlike projecting posterior border of the shell. Heart-shaped groove very small, very indistinctly pronounced, often only perceptible in a slightly expressed furrow between the combined central places of attachment—the projecting tip of the central groove. Median swelling of the small shell beginning as a distinctly developed roundish ridge under the hollowed area, between the places of attachment of the central muscles, which are there situated, and ending with a fine short furrow between the places of attachment of the anterior lateral muscles, which are also moved very far back. Principal vessel furrows of both shells deeply sunk, hollowed into plainly round or flat furrows; in the large shell more approximated to the median line and running rather straight; in the small shell more approximated to the lateral borders. Secondary vessels not ramified, radiating inwardly and outwardly perpendicularly to the principal vessels.

Peduncular muscles fastened to a toothlike process, which is pushed before the opening of the peduncular groove and reaches freely into the splanchnocœle. The places of attachment of the umbonal muscle, in the large shell, on both sides of the place of attachment of the peduncular muscle on the narrow sides (perpendicular to the plane of the shell border), which stands out into the interior of the shell; in the small shell on a platform, which lies opposite to the place of attachment of the peduncular muscle and projects into the interior like a pier. Combined places of attachment of the transmedian and anterior lateral muscles with the large shells in front of the divided places of attachment of the umbonal muscles on the narrow side of the projecting rimlike border of the shell; with the small shell at the corresponding place in similar position to the places of attachment of the transmedian muscles; and in front of these the combined places of attachment of the middle and outside lateral muscles. Places of attachment of the central muscles in the large shell behind those of the outside lateral muscles, lying on both sides of the projecting

tip of the central groove. Both places of attachment narrow, long drawn out, and placed transversely to the shell. On the facing ends of the places of attachment of the outside lateral muscles and divided by the projecting tip of the central groove the small, round, quite deeply depressed places of attachment of the middle lateral muscles. Places of attachment of the central muscles in the small shell moved far into the excavated tip of the beak, lying under the platform which serves the umbonal muscle as a place of attachment; very much prolonged, divided from one another by the median swelling. Places of attachment of the anterior lateral muscles of the small shell likewise moved very far toward the posterior, lying about in the posterior third of the shell, divided by a fine furrow at the end of the swelling.

Parietal band moved away from the places of attachment in its anterior part, coursing at the border of the scalariformed terraces of thickening.

Observations: The immature shells of this extraordinary species show unmistakably the characters of the genus *Obolus*, while these latter are not so easily distinguished in adult individuals. This is especially the case with the characters of the inner surfaces of the shell, which acquire an entirely altered appearance in consequence of the formation of the shell, which varies in age, and the altered disposition of the thickening of the shell.

The relative height of the adult shell is larger than that of the young. In the same mentioned specimens it amounts to 0:171; 0:307; 0:262. The falling off of the arching to the tip of the beak is very flat with the young shell; with the old, as a rule, perpendicular. However, essential aberrances take place with the adult individuals; some show the falling off of the beak considerably flattened.

As with all other ornamented species, the ornamentation of the onter surface of the shell is altered with the advancing age of the animal. The delicate concentric striation has no waves until the close of the first vegetative period and reminds one with its parallelism (in a strict sense) of that of *O. silurieus*. At times, however, it shows some irregularities, as the parallel uniformly curved ribs at times flow together or become disturbed. With the beginning of the second vegetative period the waves occur, which, however, are often disturbed in form, and are resolved into separate small swellings. This ornamentation Volborth has fitly named "undulate-humped." Toward the anterior border the swellings are crowded again, the waves become smoother, and the concentric ribs flatten, so that the ornamentation is almost lost close to the anterior border.

The construction of *O. antiquissimus*, in comparison with the other Oboli, is somewhat negligent, if we may use that term. The growth lamellæ lie very irregularly on one another and protrude very unequally with their anterior sharp borders; at the same time the coherency of the lamellæ is so loose that they fall apart at the least occasion. The irregularity of the construction of the shell is shown principally at the posterior borders, at which the lamellæ are displaced perpendicularly under one another, and on account of unequal stratification give the appearance of the leaves of an uncut book.

The individual rings of the growth lamellæ (taking the latter as a whole, not only the visible parts on the surface of the shell) are very massive with *O. antiquissimus*, and are club-shaped toward the beak, in the profile, as with other species. But while in the remaining species they at the same time become narrower (crescent-shaped) toward the beak, they here retain their breadth to the traces of the pseudo-area of the area lamellæ and then pass over (in the splanchnocœlic part of the area of the base) into a position perpendicular to the plane of the border of the shell. The breadth of the rings (surface of displacement) increases with the advancing age of the shell, independently of whether the existing vegetative period produces a thin or thick lamella. The thickness is understood as the perpendicular distance between the surfaces of separation.

According to this, the construction of the shell takes place as follows: At the anterior border the growth lamellæ are separated in ordinary manner, each one sticking halfway under the preceding one. Toward the posterior the individual rings are pushed more and more below one another until they lie perpendicularly below one another at the posterior borders of the shell. Now, as every new ring surpasses the preceding in breadth, and the splanchnocœle is nominally reduced in thickness, the rings, which lie perpendicularly upon one another, form a very massively hollowed border, similar to a rim, at the posterior borders of the shell, which is also continued even in the beak. There, however (between the traces of the pseudo-area), they are built up by the lamellæ of the splanchnocœlic part of the area, which lie in front of one another, perpendicular to the plane of the border of the shell. In the umbonal part of a small shell the described lamellæ (which lie over each other) of the posterior lateral borders, as well as the posterior border of the shell which is formed by the splanchnocœlic area lamellæ, may be seen distinctly.

A principal distinction between the construction of the shell of *O. antiquissimus* and that of the other species is not present. The strengthening of the principal part of the shell (which incloses the visceral cavity) takes place with the first named through strengthening of the onter lamellæ at the expense of the inner thickening, but with the other species through strengthening of the inner thickening at the expense of the onter lamellæ.

A noteworthy appearance, which has only been noticed with *O. antiquissimus*, deserves to be emphasized. The ring-shaped lamellæ of the anterior part of the shell consist of rock-mass (limestone), but are, as all lamellæ, clothed with a homogeneous (corneous) layer, so that it gives the impression that the individual lamellæ had been hollow and after the death of the animal had been filled with calcareous mud. It is, however, more likely that the inner layer of the canal, which is less capable of resistance, was dissolved after the death of the animal and restored by the penetrating calcareous mud.

In still greater measure than through the just described formation of the border the configuration of the inner surface of the shell becomes altered through the disposition of the lamellæ of thickening, which deviates in the age of the

animal. The large shell of a youthful specimen is not essentially distinguishable in the general arrangement of the characters from the typical species, unless stress be laid on the extraordinarily strongly shortened splanchnocœle. In one specimen a slight swelling is already noticeable, which, however, does not extend to the splanchnocœle, but, moved from the places of attachment of the muscle far to the front, lies in the brachiocœle. Another already shows the beginning of the formation of terraces in the form of two slight obliquely placed swellings, which are connected in advance growth and widen out to a surface whose border (which faces the beak and falls off perpendicularly) shows an inlet corresponding to the protruded tip of the central groove in the median line of the shell. In further growth of the shells one terrace is built upon the other, each following the other scalariformly, receding from the border of the preceding one and thus gradually forming the mass. This thickening of the shell is extended only on the central part of the shell. At both sides deep, broad furrows remain, which are retained for the principal vessels. Most likely the mass is gradually flattened toward the anterior border. Unfortunately, all specimens are injured in such a manner that nothing definite could be ascertained.

With the small shell the thickening takes place in entirely similar manner. Here the terraces are chiefly separated by the lateral angular places of the brachiocœle, which are formed by the protruding splanchnocœle and form a mass scalariformly sloping, which cuts deep into the protruding splanchnocœle. A youthful specimen of the small shell shows a strongly developed mass, which, however, was for the greater part destroyed by the treatment with dilute hydrochloric acid. This manner of preparation was chosen to lay bare the posterior parts under the deeply hollowed umbonal border, which was also satisfactorily accomplished at the expense of the strongly weathered lamellæ of thickening.

Of the characters whose development is connected with the thickening of the posterior part of the shell, as the septa, corneous processes, and heart-shaped groove, nothing is to be discovered in the adult shells of *O. antiquissimus*. In young specimens, however, the central groove is mostly distinguishable, even if it is always very small, flat, and indefinitely bordered.

The principal vessels are sunk in the small shells in the usual manner, but are not divided by a middle swelling. With the adult they run in deep furrows at both sides of the central mass. Their course can not be followed in the anterior half of the shell on account of the injured condition of the shells. The accessory vessels and the peripheral canal are only perceptible in indistinct traces. The former seem to run without branching, and perpendicularly to the principal vessels.

The places of attachment of the muscles of *O. antiquissimus* have in general the same arrangement as those of the typical species. In the latter those which lie more toward the center of the shell and toward the anterior are, however, corresponding to the disposition of the splanchnocœle, strikingly long drawn out.

The peduncular muscle and the divided umbonal muscle are attached in the young shells exactly in the same manner and at the same place on the bottom of the shell of the ventral valve as in the other species. In further growth of the shells small elevations are formed at the places of attachment. The progressing development of these elevations may be followed in a series of shells. The center one of these elevations is gradually altered through corresponding attachment of the lamellæ into a toothlike process, which reaches in front of the peduncular groove freely into the splanchnocœle and serves the peduncular muscle as a place of attachment. The places of attachment of the divided umbonal muscle have gradually moved to the rimlike border of the shell (close to the peduncular furrow), whose narrow sides are turned inward. The combined spots of attachment of the transmedian and anterior lateral muscles of the large shell undergo the same change of place.

The case is entirely similar with the places of attachment of the small shell, which lie at the base of the area, and the pleurocœle (umbonal, transmedian, outside lateral, and middle lateral muscles). They all move, in the adult individuals, into a place corresponding to their position in the youthful shell, to the narrow side of the rimlike border which surrounds the posterior part of the shell. The place of attachment of the umbonal muscle acquires, aside from this, a special broadening in the form of a pier-shaped platform, which protrudes into the inside of the shell. The pierlike construction gives this place of attachment of the umbonal muscle, which (judging by the mutual attrition of the beaks) displays a considerable strength, a special firmness.

All these places of attachment, which lie at the border of the shell, are grained like shagreen, coffee-brown colored, and covered with small, lustrous, dark-brown knots.

More important than those just described is (in comparison with the typical species) the dislocation of the places of attachment, lying in the interior of the shell. They all are, in consequence of the extraordinary shortening of the splanchnocœle of this species, pushed back so far toward the beak that (especially with the small shell) an entirely distorted figure of the typical figure is brought about. The position of the combined central places of attachment of the large shell is in this regard less striking. The latter are, to be sure, moved so near to the area that only a small triangular space is left for the central groove, but the difference between this arrangement and that with *O. celatus orbiculatus* is, however, proportionately slight. Of greater importance is the aberrancy in the opposed position of the individual spot of attachment of this complex, in which, as already often mentioned, the places of attachment of the central muscles are arranged behind those of the outside lateral muscles. The combined central places of attachment could not be demonstrated in the only adult specimen of the large shell; they are lost in the strongly developed configuration of the inner surface.

The small shell, on the other hand, presents an entirely singular view. The strongly developed places of attachment of the central muscles are, with the young shells, pushed back to the most posterior part of the splanchnocœle, and lie under the platform which serves the umbonal muscles as a place of attachment, and which covers the same.

In the first-mentioned specimen, the entire posterior part is broken off, so that the long-drawn-out elliptic places of attachment (immediately in front of the foot of the broken-off platform) are visible. The second specimen had to be figured from a front view, to make the covered places of attachment visible. Between the places of attachment of the central muscles (which in *O. antiquissimus* lie nearer one another than with the other species) the slightly developed but distinctly visible median swelling comes in and is produced in the known manner as far as between the places of attachment of the anterior lateral muscle, which are also moved considerably toward the posterior.

FORMATION AND LOCALITY.[a]—**Passage beds** between the Upper Cambrian and the Ordovician: "Glauconite limestone" at the following localities: (**396i**) At Fall, 15 miles (24 km.) west of Reval; (**396d**)[a] at Domglint, in Reval; (**396h**) at Tischer, 10 miles (16 km.) west of Reval; (**396j**) at Nömmeweske, near Palms; (**337h** [Eichwald, 1860, p. 929]) *Orthoceratite* limestone near Reval; and (**396o**) in the entire western part of the east Baltic region; all in the Government of Esthonia, Russia.

(**396k**) "Glauconite limestone" at Iswos on the Wolchow; (**396z**) limestone in the vicinity of Zarskoe Selo; (**395w**) chlorite-bearing sands in the limestone beds at Pawlowsk, near St. Petersburg; (**336e**) *Orthoceratite* limestone at Pulkowa, near St. Petersburg; and (**396l**) "glauconite limestone" at Pulkowa, near St. Petersburg; all in the Government of St. Petersburg, Russia.

(**396m**) "Lower lenticular layer" of the "glauconite limestone" at Saggad, east of Palms; (**396n**) white limestone between the "glauconite limestone" proper and the sandy representatives of the "Vaginatum limestone," at Leppiko, near Leetz, on the eastern side of the Baltischport Peninsula, about 25 miles (40.3 km.) west of Reval; (**396g**) *upper limestone at Reval;* (**396x**) chlorite-bearing sands in the limestone beds at Baltischport, about 30 miles (48 km.) west of Reval; (**396y**) chlorite-bearing sands in the limestone beds at Reval; (**336d**) *Orthoceratite* limestone at Reval; and (**396p**) strata between the "lower lenticular layer" and the "Vaginatum limestone" proper, at Nömmeweske, near Palms; all in the Government of Esthonia, Russia.

(**386b**) Drift blocks of "glauconite limestone" near Wehlau, 30 miles (48 km.) east of Konigsberg, East Prussia, Germany.

OBOLUS (ACRITIS?) RUGATUS Walcott.

Plate XIII, figure 2.

Obolus (Acritis?) rugatus WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 694. (Characterized as a new species.)

The concentric surface lines which are the characteristic feature of this shell, although much coarser, are the same type as those of *O. (Acritis) antiquissimus* (Eichwald) and terminate on the posterolateral margins in much the same manner. It is a very rare form, only one specimen having been collected, although the beds in which it occurs were very thoroughly searched during the survey of the Eureka mining district. All that is known of the species is shown by the figure illustrating it. It is probably not an *Acritis* and probably not an *Obolus*. The peculiar surface, as shown in Plate XIII, figure 2, is very much like that of a Silurian species named by Clarke *Glossina acer*.[b]

This form owes its specific name to the coarseness of the concentric surface lines.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**58**) Shaly limestone in upper beds of Secret Canyon shale, east side of New York and Secret canyons, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

SCHMIDTIA Volborth,[c] subgenus of OBOLUS.

Schmidtia VOLBORTH, 1860; see Marshall's Nomenclator Zoologicus, p. 137.
Not *Schmidtia* BALSAMO-CRIVELLI, 1863. (Proposed for a genus of Porifera.)
Schmidtia VOLBORTH, 1869, Verhandl. Russ.-kais. min. Gesell. St. Petersburg, 2d ser., Bd. 4, pp. 208–209. (Discussed in German.)
Schmidtia Volborth, DALL, 1877, Bull. U. S. Nat. Mus. No. 8, p. 62. (Notes on use of generic name *Schmidtia*).
Schmidtia Volborth, ZITTEL, 1880, Handbuch der Palæontologie, Bd. 1, Abth. 1, p. 665. (Described in German.)
Schmidtia Volborth, OEHLERT, 1887, Manuel de conchyliologie, by Fischer, p. 1263. (Described in French.)
Schmidtia Volborth, HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 244. (Described.)
Schmidtia Volborth, HALL and CLARKE, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, p. 560. (Copy of preceding reference.)

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[a] Locality **396d** is represented in the collections of the United States National Museum. With the exception of Locality **337h** the remaining localities are cited from Mickwitz [1896, p. 213].

[b] Clarke, J. M., New York State Museum, Memoir 9, 1908, pp. 214–215, Pl. XLVII, figs. 7 and 8.

[c] The synonymy for this subgenus does not give a complete record of the various genera under which the species now included in *Schmidtia* were formerly placed: it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Ungula Pander [1830, p. 59].
Obolus (Lingulella) Walcott [1898b, Pl. XXVI, figs. 1 and 2].
Obolus Wiman [1902, pp. 62 and 63].
Obolus Moberg and Segerberg [1906, p. 65].
Obolus Westergård [1909, p. 56].

Schmidtia Volborth, Hall and Clarke, 1892, Nat. Hist. New York, Palæontology, vol. 8, pt. 1, p. 83. (Discussed.)
Obolus (*Schmidtia*) (Volborth), Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, p. 158. (Described and discussed in German; see below for translation.)
Obolus (*Schmidtia*) (Volborth), Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 683. (Characterized.)
Obolus (*Schmidtia*) (Volborth), Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 144. (Classification of genus.)

The original description by Mickwitz follows:

The subgenus *Schmidtia*, out of all the subgenera of Eichwald's genus, is most closely related to the subgenus *Euobolus*. Some species of that subgenus, especially *O. celatus* and to a less degree *O. crassus*, show in their general appearance so much resemblance to *O. apollinis* that they might pass for miniature models of it. The other two species, on the contrary, depart from the typical species in the form of the valves and in the shape of the area; *O. obtusus*, in outline and in the flatness of its valves, rather resembles *Lingula*, while *O. acuminatus* has a very peculiar form, differing from all Oboli, and due in part to the peculiar conformation of the apex of the beak.

The main arguments for establishing a special subgenus *Schmidtia* alongside of the subgenus *Euobolus*, aside from the extraordinary smallness of the valves, are: the absence of radial striation of the surface of the valve; the absence of longitudinal striation from the slope of the thickened posterior part of the valve, as well as of the posterior edge of the central pit; the invariably more uniform thickening of the valves, manifested in this, among other things, that the pleurocœlic parts of the valves differ in nothing from the frontal and side edges; the fact that the area of the large valve is broken in the plane of the pedicle furrow; the pit-shaped depression of the splanchnocœlic part of the area of the small valve; the pestle-shaped form of the central pit; the recession of the horn-shaped projections and of the sinus of the small valve, while the median ridge simultaneously predominates. A further difference seems to exist in the different conformation of the inward-radiating secondary vessels, which in some species of the subgenus *Schmidtia* are variously ramified, whereas in the subgenus *Euobolus*, so far as can be seen, they are more rectilinear and less branched. Still the knowledge of these organs in the species of the two subgenera is as yet too imperfect to permit a definite statement.

Type.—*Schmidtia celata* Volborth.

Observations.—The reasons stated by Mickwitz [1896, p. 158] for establishing *Schmidtia* as a subgenus of *Obolus* are essentially those that differentiate it from *Lingulella*. The species of the latter subgenus are radially striated and the shells are uniformly thinner. So far as known, all of the species of *Schmidtia* are those described by Mickwitz from the *Obolus* beds of Russia. In order to place before the student full details of the species, I have had drawings made from the original specimens received from Mickwitz, and have also introduced the greater portion of his detailed descriptions. In order also that there may be a reference in this monograph to the varieties Mickwitz has determined, these are included in the synonymy of the different species referred to *Schmidtia*.

The subgeneric name was given in honor of Dr. Fr. Schmidt, of St. Petersburg, Russia.

Obolus (Schmidtia) acuminatus Mickwitz.

Plate XIV, figures 2, 2a–c.

Obolus (*Schmidtia*) *acuminatus* Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 179–183, Pl. II, figs. 39 and 40. (Described and discussed in German as a new species; see below for translation.)
Obolus (*Schmidtia*) *acuminatus alatus* Mickwitz, 1896, idem, pp. 183–184, Pl. II, figs. 41 and 42. (Described and discussed in German as a new variety.)
Obolus (*Schmidtia*) *acuminatus humeratus* Mickwitz, 1896, idem, pp. 184–186, Pl. II, figs. 43 and 44. (Described and discussed in German as a new variety.)
Obolus (*Schmidtia*) *acuminatus subtriangularis* Mickwitz, 1896, idem, pp. 186–187, Pl. II, figs. 45 and 46. (Described and discussed in German as a new variety.)

The original description by Mickwitz follows:

This remarkable species comprises, as the preceding, a number of forms essentially deviating from one another (especially in outline), whose unity can be safely asserted only by the agreement of certain characters important for the distinction of different species of the subgenus *Schmidtia*. To these belong, in the first rank, the peculiarly developed beak, with the aberrantly placed indications of a pseudo-area, which stands in a certain opposition to that of *O. obtusus*. The latter shows, as we have seen, this part of the shell flat, obliquely truncated, and the traces of a pseudo-area far removed from the peduncular groove. With *O. acuminatus*, on the contrary, the beak is highly arched, inwardly bent, and the traces of a pseudo-area coincide with the borders of the peduncular groove.

Diagnosis: Shells small; large shell (ventral valve) strongly arched, small shell (dorsal valve) more weakly. Greatest height of both shells directed more toward the beak. Outline oval. Beak of the large shell high, pointed, falling off steeply toward the tip of the beak and the umbonal borders. Tip of the beak bent inward. Anterior border

of the large shell somewhat receding from the plane of the lateral borders. Beak and anterior border of the small shell somewhat projecting beyond the same. Shell borders thin, sharp edged, in the small shell formed like the border of a plate. Outer surface of the shell polished, somewhat irregular because of unequally deeply cut concentric furrows, and rough toward the front because of the projecting borders of the lamellæ. Area small, in the large shell triangular; in the small, shaped like a band. Splanchnocœlic part of the large shell reduced to the borders of the peduncular grooves; with the small excavated into narrow furrows. Pleurocœlic parts of the large shell deeply hollowed out; in both, at the base, posteriorly somewhat caudate, extended, and drawn out into the lateral borders. Peduncular groove parallel-bordered, narrowing as a rule toward the apex of the shell in the excavation of the area supported by a bridge. Traces of a pseudo-area on the large shell coinciding with the borders of the peduncular groove or running very close to the same; in the small shell in similar position, including between them the narrowly grooved, excavated, splanchnocœlic part of the area surface. Shell thickening slight. Median septum under the magnifying glass mostly perceptible, in the large shell often in connection with the bridge supporting the peduncular furrow. Lateral septa receding. Median swelling of the small shell plainly developed, between the places of attachment of the anterior lateral muscles in the form of a sharp ridge. Posterior part of the central depression very widely extended; anterior part parallel-bordered, at the tip scarcely broadened.

Observations: *O. acuminatus* is, next to *O. obtusus*, the most characteristic species of the subgenus. The most essential differences of these two species, which lie in the formation of the beak, have been referred to in the beginning. For the rest they also differ so far from each other in the form and size of their shells that a confusion of them is prevented. The external characters which separate *O. acuminatus* from the two other species of the subgenus *Schmidtia* are less striking.

From *O. celatus* the species now in question is separated externally principally through the oval outline, in the more considerable height of their shells, whose greatest height lies more toward the beak; from *O. crassus*, to which it is closely related in relation to the outline and height of the shell, through the steeper falling off of the arching toward the tip of the beak. The shells of the last-named species have likewise an oval outline, but the relative breadth of the same is greater. Also the arching of the shells in *O. crassus* is somewhat stronger in the middle, but the greatest height lies more toward the center of the shell. The S-shaped section of the border of the large shell of *O. acuminatus*, to which a slight concavity in the small shell corresponds, was also noticed in *O. celatus præcisus;* but here also the broad oval outline of the shells of this variety and the flat falling off of the arching of the tip of the beak give a certain and distinctive external character.

The relations are shown more clearly by comparing the average characters of the respective relative numbers than by figures and descriptions.

The aberrant characters, which are present in the interior of the tip of the beak, are by far more important for the distinction of the species than the external differences of form. The most characteristic among these is the position of the traces of the pseudo-area, which in *O. acuminatus* run parallel and coincide with the peduncular groove; in *O. celatus* and *O. crassus*, however, they are removed from the latter and converge posteriorly.

The form of the shells of *O. acuminatus* shows but slight deviations. In some specimens the highly arched beak of the large shell, which falls off steeply posteriorly and laterally, is somewhat more sharply pointed and the tip of the beak seems to be compressed toward the side. In others the S-shaped section of the border of the large shell is more slightly wavy, but in the differences of form no rule can be perceived. It is similar with the small shells.

In regard to regularity, however, the outer surface of the shell seems to be subject to greater deviations than the foregoing species in their concentric striations. Besides forms with entirely smooth and lustrous shell surfaces, some occur that have very irregularly deep sculptured concentric furrows, which become especially irregular toward the anterior border and give the shells a dull aspect.

The area is in both shells very unevenly striate, and in the large shells, on account of the fracture in the peduncular furrow and the somewhat incurved tip of the beak, it is, as a rule, slightly excavated. With normally built shells the traces of the pseudo-area show slight inclination to separate themselves from the borders of the peduncular furrow; and the deviations (which some specimens pointing to the variety *alatus* show in this direction) are always very small. In the small shell, whose traces of a pseudo-area lie opposite those of the large shell, these deviations show themselves in a greater breadth of the furrow similar to the peduncular groovelike furrow which forms the splanchnocœlic part of the area.

The crowding of the splanchnocœle into the beak of the large shell (which is conditioned by the high arching and the uniformly slight thickening of the same) is only a more marked form of the groove-shaped excavation of the base of the area. Shells whose beaks are more flatly arched show as a rule a more distinct thickening of the posterior part, and, in connection therewith, an unexcavated, massive tip of the beak. The same is also the case with the small shells of this species. Likewise the bridge supporting the peduncular furrow is foreshadowed in that the groovelike hollowing out of the base of the area at the mouth of the peduncular furrow is transplanted into the splanchnocœlic part.

The inner configuration of the shells is, on account of the defective thickening, as a rule slightly pronounced. An exception is formed by the spots of attachment of the central muscles of both shells and the median swelling of the small shell, which are always easily perceptible. The former are shown deeply sunken in the large shell, and in the roundish form characteristic for the Schmidtias, while the laterally situated places of attachment of the outside lateral muscles are only slightly deepened, but are separated from those by a distinct ridge. In a small shell the places of attachment of the central muscles appear in the form of strong protuberances. The median swelling is, in opposition to that of *O. obtusus*, at its anterior border (between the places of attachment of the anterior lateral muscles) undivided, and posteriorly united with the feeble median septum. In a large shell the latter appears as a very sharp, small ridge.

Of the remaining places of attachment of the muscles there are also plainly to be seen the ones lying in the neighborhood of the area in the small shell, while they are lost, in the large shell, in the border of the excavation.

The central depression in the large shell is always very shallow.

Of the circulatory system are to be distinguished only the posterior ends of the principal vascular canals, under the magnifying glass.

The accessory vessels and the peripheral canals, on the contrary, are so feebly developed on all the observed specimens that only indistinct traces are perceptible by reflected light.

FORMATION AND LOCALITY.—**Upper Cambrian**: *Obolus* sandstone at the following localities: (**395**)[a] *at Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval;* (**395a**) at Tihala, near Jegelecht; (**395b**) at Ilgast; (**395c**) at Asserien, 75 miles (121 km.) east of Reval; (**395d**) at Ontika, about 95 miles (153 km.) east of Reval and 30 miles (48 km.) west of Narwa; and (**395e**) at Isenhof, 85 miles (137 km.) east of Reval; all [Mickwitz, 1896, p. 183] in the Government of Esthonia, Russia.

OBOLUS (SCHMIDTIA) CELATUS (Volborth).

Plate XIV, figures 1, 1a–c.

Ungula ovata PANDER, 1830, Beiträge zur Geognosie des russischen Reiches, p. 59, Pl. XXVIII, fig. 6a–b (not Pl. III, fig. 23, referred to *Obolus apollinis*). (Characterized in German.)

Schmidtia celata VOLBORTH, 1869, Verhandl. Russ.-kais. min. Gesell. St. Petersburg, 2d ser., Bd. 4, pp. 209–212, Pl. XVII, figs. 1–6. (Described and discussed in German as a new species.)

Schmidtia celata Volborth, HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 244, figs. 248 and 249. (No text reference. Figs. 248 and 249 are copied from Volborth [1869, Pl. XVII, figs. 1 and 4, respectively].)

Schmidtia celata Volborth, HALL and CLARKE, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, p. 560, figs. 248 and 249. (Copy of preceding reference.)

Schmidtia celata Volborth, HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 83, figs. 37 and 38. (No text reference. Figs. 37 and 38 are copied from the figures given in the two preceding references.)

Obolus (*Schmidtia*) *celatus* (Volborth), MICKWITZ, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 159–163, Pl. II, figs. 19 and 20. (Described and discussed in German; see below for translation.)

Obolus (*Schmidtia*) *celatus orbiculatus* MICKWITZ, 1896, idem, pp. 163–165, Pl. II, figs. 21 and 22. (Described and discussed in German as a new variety.)

Obolus (*Schmidtia*) *celatus præcisus* MICKWITZ, 1896, idem, pp. 166–167, Pl. II, figs. 37 and 38. (Described and discussed in German as a new variety.)

Obolus (*Lingulella*) *celatus* (Volborth), WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, Pl. XXVI, figs. 1 and 2. (No text reference. The specimens represented by figs. 1 and 2 are redrawn in this monograph, Pl. XIV, figs. 1a and 1c, respectively.)

Obolus celatus orbiculatus (Mickwitz), WIMAN, 1902, Bull. Geol. Inst. Univ. Upsala, vol. 6, pt. 1, No. 11, p. 62. (New locality mentioned in German.)

Obolus celatus orbiculatus (Mickwitz), MOBERG and SEGERBERG, 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), p. 65. (Mentions locality given in preceding reference, in Swedish.)

Obolus celatus orbiculatus (Mickwitz), WESTERGÅRD, 1909, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 4 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 20), p. 56. (Locality mentioned in Swedish.)

The original description by Mickwitz follows:

This species was first described by Volborth, who also gave us the first knowledge of a part of the places of attachment of the muscles. The first figure of a small shell is, however, found in Pander's above-cited work as *Ungula ovata;* but this drawing lacks all internal characters with exception of the plate-shaped border of the shell, which Volborth also mentions. Much more exact drawings of a whole series of Schmidtias (without names or description) are preserved to us in a sheet among the papers left by Pander, which was kindly handed over to me by Professor Lahusen. The places of attachment of the muscles, especially of the small shells, are in some of these figures present in full proportion, but, to be sure, not disentangled as their individual constituent parts. Also on one specimen of a large shell are plainly designated the principal and accessory vessels (which radiate inwardly). I have not utilized these drawings in any present work, because my material is much more complete than that of Pander, and, moreover, the species described by me could not with sufficient certainty be identified with the drawings in question.

Diagnosis: Shells small, slightly arched; arching of the small shell slighter than that of the large shell. Outline of the shells roundish, umbonal border of the large shell rectilinear. Surface of shell very smooth and lustrous; concentric striation very fine, in thickness somewhat irregular. Anterior (*Stirn*) and lateral borders thin, sharp margined; those in the small shell usually somewhat thickened, with the umbonal borders lying in one plane. Area small, in the large shell slightly interrupted in the peduncular furrow; in the small shell, in the splanchnocœlic part, deepened

[a] Locality **395** is represented in the collections of the United States National Museum.

into a depression; peduncular furrow shallow but plainly developed, slightly diminished toward the tip of the beak. Traces of a pseudo-area bent slightly concave to the area lamellæ at the median line of shell, converging into the tip of the beak. Shells almost uniformly thick, toward the beak only a little thickened. Traces of the principal vessels broad, shallow, little prominent; middle swelling and lateral furrows of the same scarcely projecting. Secondary, inwardly radiating vessel traces in the large shell in the principal direction perpendicular to the principal vessels; in the small one curved anteriorly, in both very indistinctly ramified. Central groove of large shell pestle-shaped, with a slight swell. Apex of central groove relatively broad, somewhat drawn out, parallel-bordered, generally somewhat involved with the combined central places of attachment of the muscles. Median swelling of small shell distinctly developed, growing over into the median septum, at times separated by a fine median groove. Corneous processes and sinus receding very much.

Observations: *O. celatus* varies as all *Obolus* species in its external form and internal configuration of its shells. The want of space, however, forbade the illustration of these alterations in a manner similar to that used for the principal species of Eichwald's genus. I had to restrict myself to the illustration of the extreme members of the series of forms. This remark concerns all species of the subgenus *Schmidtia*.

Aside from the form figured by Volborth, some with circular outline and others with flattened anterior border occur, which are connected with the principal forms by transitions and were demonstrated in their extreme members as *O. celatus orbiculatus* and *O. celatus præcisus*. To all members of this group, brought together as *O. celatus*, a noteworthy peculiarity of accessory nature is common which is lacking in the remaining species of the subgenus *Schmidtia*, and which, therefore, may be looked upon as a further argument for the cospecificity of the forms mentioned. This peculiarity is a fine netlike coating, which may be found on many of these shells and which often covers the surface of the shell in several superimposed layers in the form of crusts. It may indicate the existence of a bryozoan. Traces of the netlike coating are, however, also found in the specimens of the variety *præcisus*.

The tip of the beak and the anterior border of the large shell deviate in some specimens from the normal character in such a manner that both recede somewhat from the level of the border of the shell; then in the corresponding small shell the reverse occurs so that the closing of the shell is secured. The receding of the beak is nevertheless never so strong as, for example, in *O. obtusus*. The flat plate-shaped border [Volborth, 1869, p. 210] of the small shell is formed by the last separated lamella of the border, which is marked off from the remaining surface by the principal vessel furrows which course along its inner border, and, in consequence of the flatness of the small shell, it stands out more distinctly. In the large shell the principal vessel furrows are moved more toward the interior of the splanchnocœle, and as the shell also has a stronger arching, the lamellæ of the border recede farther. Besides, this formation, which is found in all species of the subgenus *Schmidtia*, is very variable in its strength and in some small shells hardly perceptible. On the other hand, it at times also occurs in the large shells in which the peripheral canals play the same part as the principal vessel furrows.

The surface of the area of the large shell in this species of the subgenus *Schmidtia* is least broken in the peduncular furrow, and the area itself reminds one of that of the typical species, especially in that the traces of the pseudo-area of the area lamellæ converge into the tip of the beak. The pleurocœlic parts of the area of both shells are only slightly prolonged into the lateral borders. On the other hand, the area of the small shell deviates from that of *O. apollinis* by the deepening of its splanchnocœlic part, which possesses in consequence of the special position of the traces of the pseudo-area in this species a subtriangular form.

The form of the central groove varies within rather wide limits. Through lateral restraint of the posterior part of the protruded parallel-bordered tip there results an irregular biscuit-shaped outline, and through compression of the posterior broad part of the central groove in the median direction, a simultaneous shortening and tapering of the anterior part. Some shells show the protruded tip laterally compressed, so that only a narrow groove is left, which is then as a rule inclosed by strong swellings. In others this groove possesses a breadth which almost equals the posterior part of the central groove. All these alterations of form, which seem subject to no law, are also peculiar to all other species of the subgenus.

The side septa and median septum are, even if slightly, developed in both shells. The former as a rule stand out more distinctly in the large shells; the latter, however, in the small ones, where it is more distinctly expressed, appears as a prolongation of the always strongly pronounced median swelling.

The corneous processes and the sinus of the small shell are rarely to be distinguished. Yet in some specimens, in reflected light under a lens, two fine ridges are seen, which converge from the external sides of the places of attachment of the central muscles toward the beak and, with the median swelling, form a triradiate figure.

In spite of their minuteness the places of attachment usually stand out distinctly, especially those of the central muscles, which in both shells as a rule are let down deeply with swelled borders. Also the separation of the combined places of attachment is attained with the help of a lens, although naturally with more difficulty than in the larger forms of Eichwald's genus. It is very difficult to perceive the places of attachment of the transmedian and the combined places of attachment of the outside and middle lateral muscles in the small shells. The places of attachment of the central muscles, as also those of the outside and middle lateral muscles of the large shell, have more roundish forms and are not so closely connected as in the species of the subgenus *Euobolus*. Noteworthy is also the somewhat deviating position of the places of attachment of the central and anterior lateral muscles in the small shell.

The direction of the longitudinal axes converge, in the former toward the beak, in the latter toward the anterior border. As these places of attachment have in by far the most cases a pronounced elongate form, this position is very striking and was also noticed by former observers [Volborth, 1869, p. 210].

Little is to be said of the vessels. It is the easiest, especially in the small shells, to distinguish the peripheral canals, which lie on the plate-shaped border and are usually perceptible under the lens. It is more difficult to perceive the principal vessels. They easily lose themselves in the small shell in the terrace of the plate-shaped border and are but seldom perceptible in the large shell in spite of their freer position.

The lateral vessels sink in their minuteness to microscopic sizes and are distinguishable only in exceptional cases by use of strong enlargement. This is particularly the case in the ramifications, which are very indefinite in this species. The figured specimens allow the vessel system to be perceived very faintly under the lens.

As a rule the parietal band is seen, and it is also faintly suggested in the figures. In the small shell it also stands out on account of the fine-grained character of the splanchnocœlic part of the shell.

Formation and locality.[a]—Upper Cambrian: *Obolus* sandstone at the following localities: (**395**) At Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval; (**395a**) at Tihala, near Jegelecht; (**395b**) at Ilgast; (**395c**) *at Asserien, 75 miles (121 km.) east of Reval;* (**395d**) at Ontika, about 95 miles (153 km.) east of Reval and 30 miles (48 km.) west of Narwa; and (**395e**) at Isenhof, 85 miles (137 km.) east of Reval; all in the Government of Esthonia, Russia.

Obolus conglomerate at the following localities: (**395g**) At Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval; (**395h**) at Tihala; (**395i**) at Ilgast; (**395j**) at Asserien, 75 miles (121 km.) east of Reval; (**395k**) at Ontika, about 95 miles (153 km.) east of Reval and 30 miles (48 km.) west of Narwa; (**3951**) at Isenhof, 85 miles (137 km.) east of Reval; all in the Government of Esthonia, Russia.

Sandstone below the *Obolus* conglomerate at the following localities: (**395m**) At Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval; (**395n**) at Tihala; (**395o**) at Ilgast; (**395p**) at Asserien, 75 miles (121 km.) east of Reval; (**395q**) at Ontika, about 95 miles (153 km.) east of Reval and 30 miles (48 km.) west of Narwa; and (**395r**) at Isenhof, 85 miles (137 km.) east of Reval; all in the Government of Esthonia, Russia.

(**336o**) Ungulite grit at Koporje, Government of St. Petersburg; and (**336p**) Ungulite grit at Kunitz, Government of Pskow; both in Russia.

Schmidtia conglomerate (part of the *Obolus* conglomerate) at the following localities: (**395s**) At Asserien, 75 miles (121 km.) east of Reval; (**395t**) at Ontika, about 95 miles (153 km.) east of Reval and 30 miles (48 km.) west of Narwa; and (**395u**) at Isenhof, 85 miles (137 km.) east of Reval; all in the Government of Esthonia, Russia.

(**321d**) Drift bowlder of *Obolus* sandstone, No. 21 [Wiman, 1902, p. 68], on Fanton Island, parish of Börstil, Province of Stockholm, Sweden.

Obolus (Schmidtia) crassus Mickwitz.

Plate XIV, figures 4, 4a–d.

Obolus (*Schmidtia*) *crassus* Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 187–193, Pl. II, figs. 47–49, 52–55. (Described and discussed in German as a new species; see below for translation.)

Obolus (*Schmidtia*) *crassus angulatus* Mickwitz, 1896, idem, pp. 193–194, Pl. II, figs. 50 and 51. (Described and discussed in German as a new variety.)

The original description by Mickwitz follows:

Obolus crassus is the most abundant species of the subgenus *Schmidtia*. Its shells are massively built and to this circumstance we are indebted for the remarkably strong development of all the internal characters, a development which has been of the greatest importance in rendering possible the determination of the organization of the genus *Obolus* Eichwald. With the large choice of well-preserved shells, specimens are found which preserve the finest detail, as, for example, the outwardly and inwardly radiating accessory vessels, the opening of the principal vessels of the large shell into the peripheral canal, etc. This development of the inner characters, standing alone among all the *Obolus* species, which, so to speak, forms the basis of the anatomical part of the present work, and in many doubtful cases has proved decisive, was the cause of directing to the shells of *O. crassus* especial attention, which finds expression in the increased number of figures and measurements.

Diagnosis: Shells small, thick. Large shell (ventral valve) strongly arched, small shell (dorsal valve) less so. Outline of shells broadly oval, umbonal borders convex. Surface of the shell faintly polished; concentric striation rather fine, not uniform. Growth lamellæ bordered by quite deeply engraved lines, toward the anterior border not strongly projecting. Shell borders massive, blunt; plate-border formation slightly developed. Anterior border and tip of the beak of the large shell mostly receding a little from the plane of the lateral border; in the small shell projecting. Area very large, triangular, unevenly striate. In the large shell somewhat broken in the peduncular groove; in the small one slightly deepened in the splanchnocœlic part; in both slightly excavated into furrows at the almost rectilinear base. Peduncular groove deeply cut, narrowing slightly toward the tip of the beak. Traces of the pseudo-area strongly developed, rectilinear, more or less converging posteriorly, separating the lateral borders.

Thickening of the shell quite regular, somewhat stronger at the splanchnocœlic part. Septa of both hardly perceptible. Corneous processes of the small shell suppressed by the strongly developed median swelling, which includes the entire protruded splanchnocœle and fills the sinus. The median swelling has a fine median furrow at the anterior border. Central groove of the large shell as a rule deeply sunken and bordered by swellings. Posterior part very broad, anterior projecting tip parallel-bordered.

[a] Locality **395** is represented in the collections of the United States National Museum; the remaining localities are taken from the references given in the synonymy. The authority for each locality cited is given in the list of localities, pp. 161–291.

Principal vessel furrows broad and flat. Central swelling of same slightly pronounced. Central swelling of the peripheral canals mostly separated into square sections by furrows which are parallel, directed obliquely outward, and which subside posteriorly. Secondary inwardly radiating vessel furrows strongly and irregularly branched; in the large shell perpendicular in their principal direction to the principal vascular canals; the posterior ones running out into the interior of the brachiocœle, those more anteriorly placed bending toward the peripheral canal and opening into the same. In the small shell these furrows take an oblique direction, anteriorly and internally from the lateral parts of the principal vascular canals but posteriorly and externally from the parts turned off toward the places of attachment of the anterior lateral muscles. Secondary outwardly radiating vascular traces in both shells rectilinear, perpendicular to the principal vascular furrows, plainly forked, close before the opening into the peripheral canal.

Places of attachment of the muscles in both shells strongly sunken, those of the central and outside lateral muscles of the large shell oval, somewhat separated from one another by a small swelling.

Parietal band in both shells plainly developed, normally running out, brought out through the fine-grained condition of the surface.

Observations: *O. crassus* reminds one, in the form of its shell, of *O. acuminatus* in relation to the position of the traces of the pseudo-area; it takes, on the contrary, an intermediate position between *O. celatus* and *O. obtusus*. The relations to *O. acuminatus* have already been mentioned (p. 443). Further, at the same place it was pointed out that the traces of the pseudo-area of both species (*O. crassus* and *O. celatus*) converge posteriorly. The difference in the position of the converging pseudo-areas of the two last-named species is, however, very essential and consists in the fact that in *O. celatus* the same opens into the tip of the beak; with *O. crassus*, on the contrary, the borders of the area intersect at a certain distance from the beak. The last can, under some circumstances, become so large that the traces of the pseudo-area maintain a subparallel position which reminds one of that in *O. obtusus*. A confounding of the two species in this rarely occurring case is meanwhile excluded on account of the high triangular area and the deviating form of the shell of *O. crassus*. In a majority of the shells the convergence of the traces of the pseudo-area is distinctly pronounced.

The high, coarsely striate area has a plump form in consequence of the pleurocœlic part being only slightly drawn out into the lateral borders, and on account of its convex external borders, which contrast strongly with those of *O. celatus*. Its base runs almost straight, is always composed, in common with the other species of the genus *Obolus*, of three shallow curves, and is slightly grooved; tip in the large shell usually recedes somewhat from the plane of the shell borders. The break in the surface of the area in the large shell, in the peduncular, is insignificant but somewhat stronger than in *O. celatus;* the sunken splanchnocœlic part of the area in the small shell has a trapezoidal form, in consequence of the special position of the traces of the pseudo-area, and is somewhat hollowed out in the median direction. * * *

The profile of the shell borders shows in both shells, as a rule, a straight line; in the small shell it is at times slightly bowed concavely. The shell borders themselves are, corresponding to the thick condition of the shells of this species, thicker and less sharp than with the other species of the subgenus *Schmidtia*.

The external surface of the shell possesses a rather coarse concentric striation, which becomes somewhat stronger toward the anterior border, but does not stand out in the projecting intricate form as observed in other species of the subgenus.

The character of the internal surface of the shell offers in general the same picture which we have learned to know in *O. celatus*. With the majority of the shells the central pit has the normal, pestle-shaped form, and is inclosed by a more or less pronounced swelling. One specimen shows the latter at the posterior border and on the sides of the depression swollen up. With another specimen it is, on the contrary, entirely absent and the central depression appears shallowed and indefinitely bordered. This shell is in a somewhat abnormal condition. It shows in profile an arrest of growth through which the greatest height is shoved toward the beak. At the same time it shows the places of attachment of the central muscles as thick protuberances—especially on the right side. The septa of both shells are very weakly developed, likewise the corneous processes of the small shell, which, as with all Schmidtias, recede before the powerfully developed median swelling. The latter is in its anterior half provided with a fine median groove.

In reference to the places of attachment of the muscles of *O. crassus* there is nothing essential to be added to the condition found in the other Schmidtias. They are found here in exactly the same position and condition as in the other species of the subgenus, so far as the modified form of the shells does not condition slight alterations. It is at all events to be insisted upon that these characters in the present species are found in a condition of distinctness, which the remaining species of the subgenus do not show in equal degree.

Into the circulatory system of *O. crassus*, on the contrary—which, through its prominent development and preservation, explains many conditions which, in the other species, must remain undecided—I shall enter more closely.

The principal vessels of the large shell of this species are moved somewhat nearer to the median line than in *O. celatus* and at times acquire a subparallel position. This character, nevertheless, is extremely variable and is dependent on the form of outline of the shell. Broader forms show these traces more approximated to the border of the shell. In the small shell the principal vessel furrows run in the manner known near the border of the shell and parallel to the same. The opening of the principal vascular canals of the large shell into the peripheral canal is plainly to be seen under a lens by reflected light. * * *

The peripheral canals show a peculiar formation, which hitherto has not been noticed in the other species of the subgenus *Schmidtia*. The median swelling of the peripheral canals (especially at its posterior parts) is separated by short, obliquely placed cross furrows, which anteriorly run inward, posteriorly outward, into a series of small square sections, which as a whole resemble a twisted ribbon. This character is somewhat inconstant and seems to appear

only in those shells whose characters, upon the whole, are strongly pronounced. It is self-evident that such fine particularities are only perceptible by strong magnification in reflected light; they could not be distinctly reproduced without impairing the value of the figures.

The secondary vessels, which radiate inwardly, vary essentially both in their course and in the manner of their ramification. In the large shell, as a rule, they ramify rectilinearly and perpendicularly to the principal vessels and throw off short branches to both sides; only those which lie more anteriorly curve toward the anterior border and open between the principal vascular furrows into the peripheral canal.

The accessory vessels run out entirely different in another specimen. Here they fork shortly after branching off from the principal vessels and take their course to the posterior part of the shell. Nothing is to be seen of an opening into the peripheral canal of the anterior border. Lastly, another shell, where these organs leave the most indistinct traces, shows an irregular confusion of treelike ramified canals, the directions of which seem to alter by every turning of the shell under the lens.

The accessory vessels of the small shell, which radiate inwardly, show similar differences. As a rule, the accessory vessels issuing from the central part of the principal vessels, turn anteriorly immediately after their exit from the latter, and are slightly curved in the shape of an S and hardly ramified. Only those lying at the extreme back bend into the angular spaces of the brachiocœle, which are formed by the parietal band; the accessory vessels, however, which ramify from the anterior, inwardly bent ends of the principal vessels, run rectilinearly posteriorly. Another specimen, however, shows the central accessory vessels directed more posteriorly and very strongly ramified.

What significance these essential deviations have in the systematic aspect can not, however, be established at present. No correlation has hitherto been obtained.

The secondary outwardly radiating vascular traces correspond, in all examined specimens, in regard to their arrangement and course. Branching off perpendicularly to the principal vessels, the straight, short traces fork before opening into the peripheral canal.

As in *O. celatus*, the parietal band may be followed as a fine furrowed swelling, and where perceptible traces are lacking it is often established through the difference in the character of the surface of the splanchnocœle and brachiocœle.

This form owes its specific name to the massiveness of its shells.

FORMATION AND LOCALITY.[a]—**Upper Cambrian:** *Obolus* sandstone at the following localities: (**395**) *At Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval;* (**395a**) at Tihala, near Jegelecht; (**395b**) at Ilgast; (**395c**) at Asserien, 75 miles (121 km.) east of Reval; (**395d**) at Ontika, about 95 miles (153 km.) east of Reval and 30 miles (48 km.) west of Narwa; and (**395e**) at Isenhof, 85 miles (137 km.) east of Reval; all [Mickwitz, 1896, p. 192] in the Government of Esthonia, Russia.

OBOLUS (SCHMIDTIA) OBTUSUS Mickwitz.

Plate XIV, figures 3, 3a–c.

Obolus (*Schmidtia*) *obtusus* MICKWITZ, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 167–171, Pl. II, figs. 23, 24, 33, and 34. (Described and discussed in German as a new species; see below for translation.)

Obolus (*Schmidtia*) *obtusus longus* MICKWITZ, 1896, idem, pp. 171–172, Pl. II, fig. 25. (Described and discussed in German as new variety.)

Obolus (*Schmidtia*) *obtusus acutus* MICKWITZ, 1896, idem, pp. 172–173, Pl. II, fig. 26. (Described and discussed in German as a new variety.)

Obolus (*Schmidtia*) *obtusus latus* MICKWITZ, 1896, idem, pp. 174–175, Pl. II, fig. 27. (Described and discussed in German as a new variety.)

Obolus (*Schmidtia*) *obtusus minutus* MICKWITZ, 1896, idem, pp. 175–177, Pl. II, figs. 29 and 30. (Described and discussed in German as a new variety.)

Obolus (*Schmidtia*) *obtusus ellipticus* MICKWITZ, 1896, idem, pp. 177–178, Pl. II, figs. 31 and 32. (Described and discussed in German as a new variety.)

Obolus (*Schmidtia*) *obtusus extenuatus* MICKWITZ, 1896, idem, pp. 178–179, Pl. II, figs. 35 and 36. (Described and discussed in German as a new variety.)

Obolus obtusus (Mickwitz)?, WIMAN, 1902, Bull. Geol. Inst. Univ. Upsala, Bd. 6, pt. 1, No. 11, p. 63, Pl. III, fig. 12. (New locality mentioned in German.)

Obolus obtusus (Mickwitz)?, MOBERG and SEGERBERG, 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), p. 65. (Locality mentioned in Swedish.)

Obolus obtusus (Mickwitz)?, WESTERGÅRD, 1909, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 4 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 20), p. 57. (Locality mentioned in Swedish.)

The original description by Mickwitz follows:

This extraordinary species, whose principal characteristics consist in the peculiar character of the area which is predominantly prolonged, consists of a large number of shells, which do not essentially deviate in outline and size. All of these forms are rare; of some of them only one was found; in consequence, their cospecificity could not be proven

[a] Locality 395 is represented in the United States National Museum collections.

in all cases through transitions. I was for a long time undecided as to whether I should refer all of these aberrant shells to one species. Nevertheless, the fact that deviations in a much greater measure are not extraordinary in other *Obolus* species, and, furthermore, the fear of multiplying the number of species without decisive reason, and, lastly, the correspondence of the different forms in the mentioned principal characters persuaded me to look upon the entire group as belonging to one species. The characteristic form was erected into a species and the others were subordinated to it as varieties. However, it is possible that with more complete material the one or the other variety will be removed from the species. At present this arrangement will make easy the general view of the forms.

Diagnosis: Shells moderately large, flatly arched, drawn out lengthwise. Outline subtriangular. Tip of beak of the large shell somewhat protruded, obtuse-angled, externally obliquely truncated; small shell almost rectilinearly cut off. Borders of the beak of the large shell receding from the plane of shell borders, going over into the lateral borders with a roundish angle. Exterior surface of shell very smooth, strongly lustrous like varnish, concentric striæ very fine. Growth lamellæ marked by somewhat coarser grooves, commonly standing out at the anterior border like shingles. Area large, splanchnocœlic part broad, band-shaped; pleurocœlic part prolonged far into the lateral borders. Plane of the area of the large shells broken in the peduncular groove, in the small shell depressed into broad grooves between the traces of the pseudo-area. Traces of the pseudo-area parallel in both shells very near to borders of area. Peduncular groove broad, flat, parallel bordered. Thickening of shell slight, inner configuration slightly pronounced. Central depression of large shell pestle-shaped, at times indefinitely flattened. Septa and corneous processes receding very much. Median swelling of small shell strongly developed, divided by a sharp furrow between the places of attachment of the anterior lateral muscles. Places of attachment of the muscles distinctly pronounced. Those of the outside lateral muscles of large shell circular, standing off from those of the central muscles and mostly separated by a roundish swelling.

Observations: The few shells of this relatively rare species which are at hand in finest preservation do not allow some necessary characters of the visceral surface to be distinguished. Especially the impressions of the lateral vessels are withdrawn from observation, although just these characters, through their wonderful development and preservation in some species of the subgenus *Schmidtia* (*e. g.*, in *O. celatus* and *O. crassus*), make possible in the highest degree the study of the vascular system in Eichwald's genus. Yet, in spite of the incomplete characterization, *O. obtusus* belongs to the best-defined species of the subgenus *Schmidtia*.

The peculiarity shows itself for the first in the predominant prolongation and the slight arching, which find their numerical expression in the respective value of b : l and h : l. These relative numbers are in *O. obtusus* smaller than in all other species of the subgenus. * * *

To the longitudinally extended form now comes the broad obtuse-angled tip of the beak, which gives the shells a subrectangular outline, and by which *O. obtusus* is distinguished as well from all other species of the subgenus *Schmidtia* as from those of the other subgenera. The tip of the beak of a large shell loses its blunt form, and the rounded angle of the posterior border of the shell disappears, so that the outline becomes more broadly oval. In similar manner the small shell is changed. The corners of the blunted tip of the beak become round, and the rectilinearly truncate tip of the beak assumes a slightly convex form.

Of less specific account than the form, but not less striking to the eye, is the more considerable size of the shells, which surpasses that of all other species of the subgenus *Schmidtia*, the average length of the large shell being 6.47 mm., while the corresponding valve of the next largest species (*O. crassus*) only attains 5.96 mm. These results refer to the species with the exception of the varieties; of the latter, *O. obtusus longus* has a still more considerable length (7.7 mm.).

The exterior surface of the shell of a specimen figured shows some short, radially placed, slight furrows on the central part of the surface; the furrows are lacking on the posterior borders. This striation can, however, only be looked upon as an occasional formation, for, even if slight furrows of the same kind can be noticed in another specimen, they are entirely missing in all other shells examined. Isolated striæ of this kind also occur in the other Schmidtias.

The formation of the area is very aberrant. While this part of the shell is generally triangular in the other species, it assumes in *O. obtusus* the form of a broad band, which hems the tip of the beak and is prolonged far into the borders of the shell. The splanchnocœlic part of the base of the area runs parallel to the borders of the beak and is, corresponding to the tip of the beak, angled in the peduncular furrow. In the small one it is rectilinear or slightly concave.

The surface of the area of the large shell sinks, as in *O. celatus*, only in a far stronger degree, from both sides toward the peduncular groove; besides this the whole surface of the area inclines obliquely toward the exterior, so that the borders of the beak recede from the surface of the border of the shell. The gap of the surface of the area in the peduncular groove is partly a consequence of the deficient thickening of the posterior part of the shell, which causes the lamellæ of the area to appear as a mere covering of the hollow tip of the beak; yet it is partly brought about by a slight lateral compression of the tip of the beak, which is also indicated at the exterior surface of the shell through a slight roundish median edge perceptible in reflected light. In the small shell these conditions occur in a similar manner, but stand out less distinctly.

Especially characteristic for this species is the position of the traces of the pseudo-area, which run parallel to the median line of the shell and are very near the lateral borders of the area. In some the posterior part of these traces seems to bend toward the tip of the beak with a roundish angle. Yet in nature the traces of the pseudo-area run rectilinearly to the posterior border of the beak and the deflecting apparent prolongations of the same are only accidental examples of more strongly sculptured striæ of the area.

This position of the traces of the area, which is far removed from the peduncular groove, appears to point to the relative size of the embryonal shells—a conjecture to which the consideration of the broad, parallel-bordered peduncular groove of *O. obtusus* has already led. In the small shell, the traces of the pseudo-area run exactly in the same manner, and inclose the flatly deepened splanchnocœlic part of the area between them, which allows a shallow, rather broad groove in the median line, opposite the peduncular groove of the large shell, to be perceptible by reflected light.

The thickening of the shells is generally very slight, and therefore the configuration of the inner surface stands out but little. Nevertheless, predominant fluctuations occur also in this species. It is noteworthy that of all the formations which stand out from the surface of the shell, the median swelling of the small shell is the most given to variations, which often degenerate in a monstrous manner. * * * The heart-shaped groove is given to similar alterations of form as we have learned in *O. celatus*, and may be partly dependent on the strength of the thickening * * *.

The places of attachment of the muscles are in general distinctly pronounced, but not so sharply bordered as with the large forms of Eichwald's genus. Especially there are here also, as with *O. celatus*, the large central spots of attachment of the large shell, only with difficulty decomposable into their constituent parts. As with the previous species, the outside lateral muscles are delimited from the central muscles and form, close to the principal vascular canals, isolated, shallow-pitted, excavated places of attachment.

Of the principal vascular canals there can be distinguished on all the specimens at hand, in both shells, only the posterior parts; in the small shells, besides, as a rule, also the ends, curved around posteriorly and directed toward the places of attachment of the anterior lateral muscles. The first are very broad, flat, and divided by a median swelling, which often appears to be a prolongation of the lateral septa. The latter in no way deviates from the usual arrangement. Of the accessory vascular canals there can be observed only slight indications of the inwardly radiating canals, which show as somewhat lighter colored lines.

FORMATION AND LOCALITY.[a]—**Upper Cambrian:** *Obolus* sandstone at the following localities: (**395**) *At Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval;* and (**395b**) at Ilgast; both [Mickwitz, 1896, p. 171] in the Government of Esthonia, Russia.

(**321e** [Wiman, 1902, p. 68]) Drift bowlder of *Obolus* sandstone, No. 17, on Fanton Island, parish of Börstil, Province of Stockholm, Sweden.

WESTONIA Walcott,[b] subgenus of OBOLUS.

Obolus (*Westonia*) WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 683 and 691. (Described on latter page, as below, as a new subgenus.)

(*Westonia*) Walcott, MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 205–206. (Copies original description, and discusses the form as a subgenus more allied to *Lingulella* than *Obolus*.)

Lingulella GRABAU and SHIMER [not SALTER], 1907, North American Index Fossils, vol. 1, p. 192. (Described as *Lingulella*, but both species that are referred to it belong with *Obolus* (*Westonia*).)

Obolus (*Westonia*) WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 144. (Classification of genus.)

Ovate, with ventral valve slightly acuminate; area of ventral valve strongly defined and divided by a relatively large pedicle groove. Surface marked by concentric and radiating striæ that are crossed by transverse, semi-imbricating, "ripple-embossed" lines. So far as known, the muscle scars and vascular markings are essentially the same as in *Obolus*.

Type.—Lingula aurora Hall.

Of the species referred to *Westonia, Obolus* (*Westonia*) *aurora* (Hall), *O.* (*W.*) *ella* (Hall and Whitfield), *O.* (*W.*) *euglyphus* (Walcott), *O.* (*W.*) *chuarensis* (Walcott), *O.* (*W.*) *stoneanus*

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[a] Locality 395 is represented in the United States National Museum collections.

[b] The synonymy for this subgenus does not give a complete record of the various genera under which the species now included in *Westonia* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Lingula Hall [1861, p. 24].
Lingula Rogers [1861, p. 390; 1862, p. 4; 1863, pp. 126 and 127; 1867, pp. 103 and 104].
Lingulella Hall [1873, p. 244].
Lingulepis Hall and Whitfield [1877, p. 232].
Lingula Barrande [1879b, Pls. CVI and CXI].
Lingulella Whitfield [1882, p. 344].
Lingulella Walcott [1886b, p. 97; 1891a, p. 607].
Lingulella Hall and Clarke [1892c, p. 58 and Pl. II, figs. 9–11 and 12–13].
Lingula Sardeson [1896, p. 95].
Lingulepis Walcott [1897a, p. 404].
Obolus (*Lingulella*) Walcott [1898b, pp. 399, 402, and 413, and Pl. XXVIII].
Lingulella Grabau [1900, p. 624].
Lingulella? Matthew [1901a, p. 270].
Lingula Wiman [1902, p. 51].
Lingulella? Wiman [1902, p. 52].
Obolus Matthew [1902c, pp. 96 and 110].
Obolus (*Westonia*) Walcott [1902, p. 611].
Lingulella Weller [1903, p. 112].
Obolus (*Westonia*) Walcott [1905a, pp. 334, 335, 336, and 337].
Lingulella Pack [1906, p. 295].
Lingulella (*Westonia*) Grabau and Shimer [1907, p. 193].
Obolus (*Westonia*) Walcott [1908d, pp. 67, 68, and 69].

(Whitfield), *O.* (*W.*) *rogersi* (Walcott), *O.* (*W.?*) *lamellosus* (Barrande), and *O.* (*W.*) *escasoni* (Matthew) all have transverse, irregular, elevated lines. In *O.* (*W.*) *stoneanus* and *O.* (*W.*) *rogersi* these lines have two or three sharp undulations near the median line, and in *O.* (*W.*) *aurora* many short and more or less irregular undulations occur on the entire central portion of the shell. Beyond the short, central undulations, more or less wave-like, long undulations extend to the sides of the valve, usually with a slight backward curvature toward the margin.

Obolus (*Westonia*) *finlandensis* Walcott, *O.* (*W.*) *bottnicus* (Wiman), and *O.* (*W.*) *wimani* Walcott, of the Middle (possibly Lower) Cambrian sandstones of Sweden, differ in surface characters from the typical species of the genus. In these species the concentric lines and striæ of growth are well marked, also radiating lines that extend from the umbo irregularly toward the front and side margins of the shell. In addition there is a series of somewhat irregular striæ or lines that terminate at right angles to the lateral margin, start in toward the center of the shell, and then curve backward so as to meet at the center, or merge apparently into the radiating striæ (Pl. XLVIII, figs. 3 and 3a). These lines were apparently formed by the same agency (the front margin of the mantle) that formed the various irregular, more or less transverse lines on the other species of the genus. The two other species from the sandstones of Sweden, *O.* (*W.*) *ålandensis* Walcott and *O.* (*W.*) *balticus* Walcott, appear to have the typical *Westonia* surface represented on *O.* (*W.*) *ella*, although it is exceedingly fine.

The generic name was given in honor of Mr. T. C. Weston.

Obolus (Westonia) ålandensis Walcott.

Plate XLVIII, figures 6, 6a.

Lingula? sp. No. 2, Wiman, 1902, Bull. Geol. Inst. Univ. Upsala, vol. 6, pt. I, No. II, p. 52, Pl. II, fig. 39. (Locality given.)

Lingulella? sp. No. 3, Wiman, 1902, idem, p. 52, Pl. II, fig. 33. (Locality given. The specimen represented by fig. 33 is redrawn in this monograph, Pl. XLVIII, fig. 6.)

Lingulella? sp. No. 5, Wiman, 1902, idem, p. 52, Pl. II, fig. 35. (Locality given. The specimen represented by fig. 35 is redrawn in this monograph, Pl. XLVIII, fig. 6a.)

Obolus (*Westonia*) *alandensis* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 334. (Discussed essentially as below as a new species.)

This species is characterized by its broad form when compared with *Obolus* (*Westonia*) *bottnicus* (Wiman), *O.* (*W.*) *wimani* Walcott, and *O.* (*W.*) *balticus* Walcott. Its surface is marked by fine concentric lines of growth, with very fine, threadlike, concentric striæ between them. In strong, reflected light, almost microscopic, transverse, very irregular lines can be seen that give the surface somewhat the appearance of that of *O.* (*W.*) *ella* (Hall and Whitfield).

For reference to the geological horizon of bowlders on Eggegrund Island, similar to the ones containing this species, see description of *O.* (*W.*) *bottnicus* Walcott, p. 454.

The species derives its specific name from its occurrence on Åland Island.

Formation and locality.—**Middle? Cambrian:** (**311j** and **311k**) Drift bowlders of bituminous sandstone, Nos. 28 and 29 [Wiman, 1902, p. 57], on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg; and (**311m**) drift bowlder of bituminous sandstone, No. 1 [Wiman, 1902, p. 57], on Limön Island, about 12 miles (19.3 km.) northeast of Gefle, Province of Gefleborg; all in Sweden.

(**311y**) *Drift bowlder of rusty sandstone* [*Wiman, 1902, p. 57*], *at Ytternäs, Slemmern, Åland Island, Finland, Russia.*

Obolus (Westonia) aurora (Hall).

Plate XLVI, figures 1, 1a–h.

Lingula aurora Hall, 1861, Rept. Supt. Geol. Survey Wisconsin, p. 24.

Lingula aurora Hall, 1862, Rept. Geol. Survey Wisconsin, vol. 1, p. 21, fig. 4. (No text reference.)

Lingula aurora Hall, 1863, Sixteenth Ann. Rept. New York State Cab. Nat. Hist., pp. 126–127, Pl. VI, figs. 4 and 5. (Described and discussed.)

Lingula aurora Hall, 1867, Trans. Albany Inst., vol. 5, pp. 103–104, Pl. I, figs. 4 and 5. (Copy of preceding reference.)

Lingulella aurora Hall, 1873, Twenty-third Ann. Rept. New York State Cab. Nat. Hist., pp. 244–245. (Merely changes generic reference.)

Lingulella aurora (Hall), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, Pl. II, figs. 12 and 13. (No text reference.)

Lingula aurora Hall, Sardeson, 1896, Bull. Minnesota Acad. Nat. Sci., vol. 4, No. 1, pt. 1, p. 95. (New localities mentioned.)

Obolus (*Westonia*) *aurora* (Hall), Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 691. (Merely changes generic reference.)

Lingulella aurora (Hall), Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 193. (Described.)

General form broadly ovate, with the dorsal valve almost subcircular, except for the gentle slope of the cardinal margins toward the low obtuse beak. The beak of the ventral valve is almost invariably broken off, as shown in Plate XLVI, figures 1a to 1d. If the cardinal slopes are restored, as in figure 1c, the form of the beak is rather obtuse. Original convexity unknown, as all of the large number of specimens in the collection are compressed and often flattened on the surface of the shaly sandstone. It appears to have been moderate like that of *Lingulella ampla* (Owen) and *Obolus* (*Westonia*) *stoneanus* (Whitfield). The shell appears to have been built up of a thin outer layer and thin lamellose inner layers. On some of the casts of the valves the character of both the inner and outer surface markings is shown.

The outer surface of the shell is marked by concentric striæ and lines of growth and a complex system of lamellose striæ. The latter are almost directly transverse near the sides of the shell and curve slightly backward over the central portion, where they have a sharp zigzag character that is highly characteristic (Pl. XLVI, figs. 1g and 1h). When the outer surface of the shell is exfoliated the surface is marked by concentric lines and striæ and fine radiating striæ (figs. 1 and 1b). This latter surface is probably caused by the markings of the inner surface of the shell and the inner surface of the outer layer or lamella, as is seen so frequently in the shell of *Lingulella acutangula* (Roemer) (Pl. XVII) and *Dicellomus politus* (Hall) (Pl. LII). The appearance of several specimens leads to the conclusion that the interior surface was more or less punctate. It frequently happens that the outer surface of the shell is worn nearly smooth, the only remaining traces of the beautiful surface ornamentation being toward the beak, or a spot here and there protected by a strong raised line of growth.

This is one of the largest shells of the genus. A ventral valve from Mazomanie is 21 mm. long, with a maximum width of 17 mm., and an associated dorsal valve is 17.5 mm. long and 17 mm. in width. The cardinal area is well defined in both valves. In the ventral valve it is divided at the center by a strong pedicle groove and toward its margins by narrow, clearly defined flexure lines. The striæ of growth cross the area parallel with its base (Pl. XLVI, fig. 1c).

The area formed a thin shelf between the pedicle groove and the lateral margins, and the undercut extended back beneath the area, but how far can not be determined, as the cast of it is broken away in the specimens in the collection.

The area of the dorsal valve is short as compared with that of the ventral valve. It extends well out on the cardinal slopes, and has a very faintly indicated flexure line near the lateral margin. The cast of the visceral cavity (v) is partly shown in figure 1a. There is a peculiar apron-like area that extends forward from the flattened cast of the pedicle groove (Pl. XLVI, figs. 1b–d) that probably represents a broad groove that existed in the interior of the shell back of the visceral cavity. No clearly defined muscle scars have been observed.

Observations.—The surface ornamentation is very characteristic, and is of the same general type as that of *Obolus* (*Westonia*) *ella*. (Compare Pl. XLVI, fig. 1h, with Pl. XLVII, fig. 1o.)

The outline of the valves is somewhat like that of *Lingulella ampla* (Owen) (Pl. XXVIII). It differs in being wider in proportion to the length. As pointed out by Hall, *Obolus* (*Westonia*) *aurora* is from the upper beds at Mazomanie and *Lingulella ampla* from the lower beds at Trempealeau.

Formation and locality.—**Upper Cambrian: (S85x)**[a] *In the upper beds of the "St. Croix sandstone," near Mazomanie, Dane County;* **(85s)** "St. Croix sandstone," at Prairie du Sac, Sauk County; **(78, 78c, and 78s)** "St. Croix sandstone" at Osceola, Polk County; **(79)** "St. Croix sandstone," in bluff near Hudson, St. Croix County; **(86)** "St.

[a] **S85x** is the type locality, though the specimens in the United States National Museum collections to which that number is assigned were collected much later than the type specimens. The species also occurs in Localities **3281 and 328p.**

Croix sandstone," at Van Ness quarry, Gibraltar Bluff, Lodi, Columbia County; and (328b) St. Lawrence formation [Sardeson, 1896, p. 95], at Osceola, Polk County; all in Wisconsin.

(339a) St. Lawrence formatiou [Sardeson, 1896, p. 95], at Otisville, Washington County; and (97 and 339c) Reeds Landing, foot of Lake Pepin, Wabasha County; both in Minnesota.

Obolus (Westonia) balticus Walcott.

Plate XLVIII, figures 7, 7a–b.

Lingulella? sp. No. 4, Wiman, 1902, Bull. Geol. Inst. Univ. Upsala, vol. 6, pt. 1, No. 11, p. 52, Pl. II, figs. 37 and 38. (Locality given. The specimens represented by figs. 37 and 38 are redrawn in this monograph, Pl. XLVIII, figs. 7a and 7b, respectively.)

Lingulella? sp. No. 6, Wiman, 1902, idem, p. 52, Pl. II, fig. 34. (Locality given. The specimen represented by fig. 34 is redrawn in this monograph, Pl. XLVIII, fig. 7.)

Obolus (*Westonia*) *baltica* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 334. (Characterized as below as a new species.)

This species is characterized by its elongate form, with the sides of the dorsal valves regularly rounded from the back to the rounded frontal margin. The dorsal valves are also more regularly and strongly convex than in other species occurring in the Cambrian sandstones of Sweden. The outer surface is marked by concentric and radiating striæ, crossed obliquely by very fine, irregular transverse striæ. The latter are only to be seen with a strong magnifier and favorable light.

For reference to the geologic horizon of bowlders on Eggegrund Island, similar to the ones containing this species, see description of *Obolus* (*Westonia*) *bottnicus*, page 454.

The species derives its name from its occurrence in the North Baltic region.

Formation and locality.—**Middle? Cambrian:** (**311h**) *Drift bowlder of bituminous sandstone, No. 26* [*Wiman, 1902, p. 57*], *on Biludden, about 20 miles* (*32.2 km.*) *east of Gefle;* and (**311o**) drift bowlder of bituminous sandstone, No. 1 [Wiman, 1902, p. 57], on Skälstenarne Island, just west of Eggegrund Island, about 25 miles (40 km.) east-northeast of Gefle; both in the Province of Gefleborg, Sweden.

(**311t**) Drift bowlder of mottled calcareous sandstone [Wiman, 1902, p. 57], at Öfverby, parish of Jomala, Åland Island, Finland, Russia.

Obolus (Westonia) blackwelderi Walcott.

Plate XXXIX, figures 10, 10a–c.

Obolus (*Westonia*) *blackwelderi* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 335. (Described and discussed as below as a new species.)

General form elongate, with the width about one-half the length; front margin broadly rounded; sides slightly arched up to the lateral slopes, which are quite straight in the ventral valve and curved toward the rounded posterior end of the dorsal valve; the beak of the ventral valve is pointed and marginal. The convexity of the valves is moderate, that of the dorsal apparently being the greater. Surface marked by concentric striæ and lines of growth which are crossed by irregular, fine, imbricating, more or less transverse lines; the transverse lines trend slightly backward toward the sides of the valves. A dorsal valve 8 mm. in length has a width of 5 mm.

Observations.—Nothing is known of the interior of the valves. When the shell is broken from the limestone, the outer surface usually adheres to the matrix. The best exteriors are those of shells on the surface of the layers. Of the known species of *Westonia*, *O.* (*W.*) *wimani* Walcott, and *O.* (*W.*) *balticus* Walcott are most nearly related to *O.* (*W.*) *blackwelderi*. The latter is a larger shell and also less narrow proportionally where the gently arching sides pass into the posterolateral slopes.

The specific name is given for Prof. Eliot Blackwelder, of the University of Wisconsin, who collected the specimens.

Formation and locality.—**Middle Cambrian:** (**C1** and **C2**) Lower shale member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 40 (part of the 3d list of fossils), and fig. 10 (bed 4), p. 38], 2 miles (3.2 km.) south of Yenchuang; and (**C6**) *thin slabby limestone in the upper shale member of the Kiulung group* [*Blackwelder, 1907a, pp. 37 and 41* (*2d list of fossils*), *and fig. 10* (*bed 12*), *p. 38*], *2.5 miles* (*4 km.*) *southwest of Yenchuang;* both in the Sintai district, Shantung, China.

Obolus (Westonia) bottnicus (Wiman).

Plate XLVIII, figures 4, 4a–c.

Lingula bottnica Wiman, 1902, Bull. Geol. Inst. Univ. Upsala, vol. 6, pt. 1, No. 11, p. 51, Pl. II, figs. 40–44. (Characterized and discussed in German as a new species. The specimens represented by figs. 41, 42, 43, and 44 are redrawn in this monograph, Pl. XLVIII, figs. 4, 4a, 4b, and 4c, respectively.)

Obolus (*Westonia*) *bottnica* (Wiman), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 335–336. (Characterized and discussed as below.)

The description of *Obolus* (*Westonia*) *finlandensis* Walcott so closely applies to this species that it is only necessary to point out the difference between the two and to compare the figures illustrating them.

The surface of *Obolus* (*Westonia*) *bottnicus* has the same concentric and radiating lines with the irregular, transverse lines terminating at right angles to the margins, curving inward and backward in such a manner as obliquely to cross the radiating lines that extend from the umbo forward to the anterior and anterolateral margins. The central scars of the dorsal valve are much farther forward in *O.* (*W.*) *bottnicus*.

Wiman [1902, p. 51] refers this species to the *Olenellus* sandstone series. The bowlder containing it also carried *Aparchites? anderssoni, Hipponicharion matthewi, Acrotreta eggegrundensis, Kutorgina?, Torellella lævigata,* and fragments referred to *Olenellus*. This fauna is essentially Middle Cambrian in its facies and unless the fragments referred to *Olenellus* are indisputably of that genus, I am inclined to refer the bowlder and its contained fossils to the Middle Cambrian. The fact that *Obolus* (*Westonia*) *bottnicus* is nearly identical with *O.* (*W.*) *finlandensis* of the Middle Cambrian of Finland also points to the Middle Cambrian age of the fauna.

The specific name is derived from the Swedish form of the word Bothnia.

Formation and locality.—**Middle? Cambrian**: (**311**) *Drift bowlder of coarse-grained, somewhat friable, glauconitic sandstone, No. 3* [*Wiman, 1902, p. 57*], *on Eggegrund Island, about 25 miles* (*40 km.*) *east-northeast of Gefle, Province of Gefleborg, Sweden.*

Specimens which were doubtfully referred to this species by Wiman occur at the following locality:

Middle? Cambrian: (**311e**) Drift bowlder of rusty sandstone [Wiman, 1902, p. 57], south of Lumparn, parish of Jomala, Åland Island, Finland, Russia.

Obolus (Westonia) chuarensis (Walcott).

Plate XXV, figures 2, 2a–e.

Obolus (*Lingulella*) *chuarensis* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 399. (Described and discussed essentially as below as a new species.)

Obolus (*Westonia*) *chuarensis* Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 691. (Merely changes generic reference.)

General form broadly ovate, almost subquadrate, with the ventral valve obtusely acuminate, and the dorsal valve rounded subquadrate, the posterior margin being broadly obtuse; convexity moderate, increasing somewhat in the older shells. Surface of shell marked by rather strong, concentric lines and striæ of growth and very fine, more or less transverse and irregular, apparently imbricating striæ such as ornament the surface of *Obolus* (*Westonia*) *ella* (Hall and Whitfield) and *O.* (*W.*) *euglyphus* (Walcott). Fine radiating striæ also appear under a strong magnifying glass. When the outer surface is exfoliated the inner layers of the shell show traces of radiating striæ. The inner surface is marked by pits or punctæ, arranged in more or less irregular concentric lines; also fine radiating striæ. The shell is strong and formed of a thin outer layer and several inner layers or lamellæ, those near the outer margin being arranged obliquely to the outer surface.

The only traces of the interior markings are those on the casts of the dorsal valve. These show a short and rather broad area, strong vascular sinuses, and traces of the anterior lateral muscle scars.

Observations.—The character of the surface ornamentation and subquadrate form of the dorsal valve lead to a comparison with *O.* (*W.*) *ella* (Hall and Whitfield) (Pl. XLVII) of the Rocky Mountain fauna. The species differs from the latter in having a thicker, stronger shell, relatively shorter in proportion to its length. The surface is also of the same type as that of *O.* (*W.*) *euglyphus* (Walcott) (Pl. XLVIII), which occurs at the same horizon in the upper portion of the "Tonto" sandstone but not associated with it. It differs from *O.* (*W.*) *euglyphus* in being much shorter and broader in proportion to its length.

The species derives its name from its occurrence in the Chuar Valley, Grand Canyon of the Colorado, Arizona.

Formation and locality.—**Middle Cambrian:** (**74**) Sandstone about 300 feet (91.4 m.) above the base of the Tonto group at the head of Nunkoweap Valley; (**74b**) sandstone about 1,000 feet (305 m.) above the base of the Tonto group, at the head of Nunkoweap Valley; (**73**) sandstones of the Tonto group in Kwagunt Valley; and (**73a**) "*Tonto*" *sandstone, in Chuar Valley;* all in the Grand Canyon of the Colorado, Arizona.

Obolus (Westonia) dartoni (Walcott).

Text figures 40A–C.

Obolus (*Westonia*) *dartoni* Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 67, Pl. VII, fig. 14. (Discussed as below as a new species. Fig. 14 is reproduced below, fig. 40A.)

This species has the general form and convexity of *Obolus* (*Westonia*) *euglyphus* (Walcott) (Pl. XLVIII, figs. 1, 1a–e). It differs in the dorsal valve being narrower posteriorly. The surface of the two species differs very much, that of *O.* (*W.*) *dartoni* being of the *O.* (*W.*) *ella* (Hall and Whitfield) type (Pl. XLVII, fig. 1o) and not like that of *O.* (*W.*) *euglyphus* (Pl. XLVIII, fig. 1f). From *O.* (*W.*) *ella* this species differs in being more elongate in outline and in having the surface more clearly marked by the crossing of the minute ridges. These ridges are slightly irregular and curve from near the umbo obliquely across the shell toward the lateral and front margins so as to form a pattern much like that shown on the front portion of Plate XLVII, figure 1e. Some portions of the surface recall that of the central portions of Plate XLVI, figure 1h. The largest ventral valve has an indicated length of 12 to 15 mm.; width, 9 mm.

A B C

Figure 40.—*Obolus* (*Westonia*) *dartoni* Walcott. A, Ventral valve, worn smooth by beach action (U. S. Nat. Mus. Cat. No. 51683a). B, Dorsal valve, worn smooth (U. S. Nat. Mus. Cat. No. 51683b). C, Enlargement of the surface, × 10 (U. S. Nat. Mus. Cat. No. 51683c).

The specimens represented are from Locality **302o**, Middle Cambrian sandstones near Garfield Peak, Wyoming. Figure 40A is copied from Walcott [1908d, Pl. VII, fig. 14]; it represents the type specimen.

The specific name was given for Mr. N. H. Darton, of the United States Geological Survey, who collected the specimens.

Formation and locality.—**Middle Cambrian:** (**302o**) Sandstones just above the granite, west of Garfield Peak, 50 miles (80.5 km.) west of Casper, Natrona County, Wyoming.

Obolus (Westonia) ella (Hall and Whitfield.)

Plate XXXIII, figures 3, 3a–c; Plate XLVII, figures 1, 1a–p.

Lingulepis ella Hall and Whitfield, 1877, U. S. Geol. Expl. 40th Par., vol. 4, p. 232, Pl. I, fig. 8. (Described and discussed as a new species. The specimen represented by fig. 8 is redrawn in this monograph, Pl. XLVII, fig. 1b.)

Lingulella ella (Hall and Whitfield), Walcott (in part), 1886, Bull. U. S. Geol. Survey No. 30, pp. 97–98, Pl. VII, fig. 2; Pl. VIII, figs. 4, 4a, 4d, and 4e (not figs. 4b and 4c, now referred to *Lingulella dubia*). (Copies original description and describes and discusses species. Fig. 4 is redrawn from the specimen represented in fig. 8 of the preceding reference. The specimens represented by figs. 2 and 4 are redrawn in this monograph, Pl. XLVII, figs. 1m and 1b, respectively.)

Lingulella ella (Hall and Whitfield), Walcott (in part), 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 607, Pl. LXVII, figs. 2, 2a–b, and 2e (not figs. 2c and 2d, now referred to *Lingulella dubia*). (Horizons mentioned. Figs. 2, 2a–b, and 2e are copied from figs. 2, 4a, 4, and 4e, respectively, of the preceding reference.)

Lingulella ella (Hall and Whitfield), Hall and Clarke (in part), 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 58, figs. 19 and 21 (not fig. 20, now referred to *Lingulella dubia*). (Species discussed in the text. Figs. 19 and 21 are copied from Walcott, 1886b, Pl. VII, fig. 2, and Pl. VIII, fig. 4a.)

Lingulepis ella Hall and Whitfield, Walcott, 1897, Am. Jour. Sci., 4th ser., vol. 3, p. 404. (Merely changes generic reference.)

Obolus (*Lingulella*) *ella* (Hall and Whitfield), Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, Pl. XXVIII, figs. 5–8. (No text reference. The specimens represented by figs. 5–8 are redrawn in this monograph, Pl. XLVII, figs. 1g, 1k, 1d, and 1i, respectively.)

Obolus (*Westonia*) *ella* (Hall and Whitfield), Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 691. (Merely changes generic reference.)

Obolus ella (Hall and Whitfield), Matthew, 1902, Trans. Roy. Soc. Canada for 1902, 2d ser., vol. 8, sec. 4, No. 3, pp. 96 and 110, Pl. I, figs. 9a–b. (Discussed on both pages.)

Lingulella ella (Hall and Whitfield), Pack, 1906, Jour. Geol., vol. 14, No. 4, p. 295, Pl. I, figs. 2 and 2a. (Mentioned, and new localities given.)

Lingulella (*Westonia*) *ella* (Hall and Whitfield), Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 193, figs. 229a–b. (Described. Figs. 229a–b are copied from Walcott [1886b, Pl. VIII, figs. 4 and 4a, respectively].)

General form broad ovate, with the dorsal valve subquadrate or rounded quadrate and the ventral valve obtusely acuminate; valves moderately convex, so far as can be determined from the crushed and flattened specimens from the shales of Utah and Nevada. Surface of the shell marked by concentric striæ and lines of growth and, on the type specimen, by very fine, irregular, lamellose, more or less transverse striæ and fine radiating lines; the surface is much like that of *O.* (*W.*) *euglyphus* (Walcott) (Pl. XLVIII); fine, clearly defined radiating lines occur on the inner layer of the shell of partly exfoliated specimens. The cast of the inner surface of the shell shows papillæ that filled punctæ in the shell; they are rather large and are arranged in the central portion of the shell in concentric lines, much as in *Lingulella davisi.* The shell is strong and rather thick in old shells. It is made up of a thin outer layer and several inner layers or lamellæ that are well shown in the figure of the type specimen (Pl. XLVII, fig. 1b).

The largest ventral valve thus far examined has a length of 16 mm. and a width of 13 mm. A dorsal valve is 13 mm. long by 12.5 mm. in width.

The area of the ventral valve is of the same type as that of *O.* (*W.*) *aurora* (Hall) (Pl. XLVI) and *Lingulella ampla* (Owen) (Pl. XXVIII). The flexure line is nearer the pedicle furrow than in *Lingulella perattenuata* (Whitfield) (Pl. XXI), *L. acutangula* (Roemer) (Pl. XVII), *Lingulella ampla*, and *Obolus* (*Westonia*) *aurora*, which results in a wider outer lateral space on the area (Pl. XLVII, fig. 1e (a′)). The pedicle furrow is strong and deeply rounded, and in one specimen referred to this species (Pl. XLVII, figs. 1d and 1g) the cast of the base of the undercut between the area and the outer shell is clearly shown on each side of the pedicle groove. The area of the dorsal valve is low and broad; the flexure lines cross it so as to form a broad, slightly elevated space in the cast corresponding to a broad, shallow furrow in the shell (Pl. XLVII, fig. 1i). The striæ of growth cross the area parallel with its base, both in the ventral and dorsal valves.

The cast of the interior of the ventral valve shows the visceral cavity (Pl. XLVII, figs. 1c, 1d, and 1g) and the median septum of the dorsal valve is seen in figures 1i and 1k.

The muscle scars are not distinctly shown on the ventral valve. In the dorsal valve the central scars (h) are preserved in specimens from Nevada (fig. 1i) and Montana (figs. 1 and 1k), and the anterior laterals in Plate XLVII, figures 1k and 1 l.

The remains of markings made by the vascular system are limited to the main or trunk sinuses of the two valves, and a portion of the parietal scar (ps) is seen on one specimen of the ventral valve (Pl. XLVII, fig. 1g).

Observations.—The type specimen of this species is a somewhat crushed dorsal valve that fortunately preserves the outer surface and much of the shell. Near the type locality, and in the same band of slaty shales, were found a number of specimens, including a series of young shells. Two of the larger shells are shown by Plate XLVII, figures 1 and 1a, and two of the

young by figures 1e and 1f. The shells found near Helena, Montana, commonly occur as casts in a siliceous shale and have the form of and appear to be specifically identical with the species in the Wasatch and Oquirrh mountains. A few specimens preserve the shell and show it to be thick and strongly laminated toward the front.

The form from the Bighorn Mountains of Wyoming appears to be identical with this species, except that the surface ornamentation is coarser and much more distinctly outlined by the zigzag, irregular, transverse striæ. The strength of the striæ and the size of the more or less rhombic interspaces range from near those of *O.* (*W.*) *ella* to more than double their size, the increase in the size of the interspaces being made more prominent by the deposition of what appears to be chalcedony on the outer surface or a replacement of the shell by chalcedony. The form of the valves and the position of the central and anterior lateral muscle scars in the dorsal valve are essentially the same as in *O.* (*W.*) *ella*.

On Gordon Creek in Montana this species occurs in association with the *Albertella helena* fauna [Walcott, 1908f, p. 202], which is referred to the highest zone of the Lower Cambrian. Four small ventral valves were found that have the form and surface characteristic of *Obolus* (*Westonia*) *ella*.

Obolus (*Westonia*) *ella* has a wide geographic distribution in the Cordilleran and southern Appalachian regions. It also has a vertical range from the summit of the Lower Cambrian in Montana and British Columbia to 250 feet up in the Upper Cambrian.

Formation and locality.—**Upper Cambrian:** (4y and 54t) Limestone of the St. Charles formation [Walcott, 1908a, p. 6], about 250 feet (76 m.) above the Middle Cambrian on the north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

(54e) About 200 feet (61 m.) above the Middle Cambrian and 1,025 feet (212.4 m.) below the top of the Upper Cambrian in limestones forming 3 of the St. Charles formation [Walcott, 1908f, p. 193], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

Middle Cambrian: (57g) About 1,700 feet (518 m.) above the Lower Cambrian and 3,250 feet (991 m.) below the Upper Cambrian, in the siliceous shales forming 2d of the Stephen formation [Walcott, 1908f, p. 211], on Mount Bosworth, north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide, between British Columbia and Alberta, Canada.

(5f) Limestone interbedded in the Wolsey shale [Weed, 1900, p. 285], in Meagher County, on the road to Wolsey, about 4 miles (6.4 km.) south of the divide at the head of Sawmill Creek, and 11 miles (17.7 km.) south of Neihart, Little Belt Mountains quadrangle (U. S. Geol. Survey), Cascade County; (340a) shales near Helena, Lewis and Clark County; (302s) dark siliceous shale in a quarry in Last Chance Gulch, south slope of Mount Helena, 1.5 miles (2.4 km.) south of Helena, Lewis and Clark County; (4u) shales in the Gallatin formation of Peale [1893, Pl. IV], northwest side of canyon 0.5 mile (0.8 km.) south of Helena, Lewis and Clark County; (9m) shale 4 miles (6.4 km.) above Walker's ranch, on North Fork of Dearborn River, in the eastern part of the Lewis and Clark National Forest, Lewis and Clark County; (4q′) limestone about 310 feet (94.5 m.) above the unconformable base of the Cambrian and 185 feet (56.4 m.) above the top of the quartzitic sandstones in a shale which corresponds in stratigraphic position to the upper part of shale No. 6 of the Dearborn River section [Walcott, 1908f, p. 202], on the ridge between Gordon and Youngs creeks, about halfway between Gordon Mountain and Cardinal Peak, Ovando quadrangle (U. S. Geol. Survey), Powell County; (4k) about 725 feet (221 m.) above the base of the Cambrian in the shales of the Gallatin formation of Peale [1893, Pl. IV], on the north side of West Gallatin (Gallatin) River, northeast of Logan, Threeforks quadrangle (U. S. Geol. Survey), Gallatin County; and (4g) about 325 feet (99.1 m.) above the base of the Cambrian in the Flathead shales of Peale [1893, p. 21], 1 mile (1.6 km.) north of the junction of East Gallatin and West Gallatin (Gallatin) rivers, 4 miles (6.4 km.) east-northeast of Logan, Threeforks quadrangle (U. S. Geol. Survey), Gallatin County; all in Montana.

(5h and 55d) About 2,000 feet (609.6 m.) above the Cambrian quartzitic beds in a shale which is probably to be referred to the Bloomington formation [Walcott, 1908a, p. 7], on the south side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County; and (55c) Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], about 50 feet (15.2 m.) above the Brigham quartzite and 2,755 feet (839.7 m.) below the Upper Cambrian, in a ravine running up into Danish Flat from Mill Canyon, about 6 miles (9.6 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County; both in Idaho.

(171a) Sandstone in Big Goose Creek Canyon, in the Bighorn Mountains, west of Sheridan, Sheridan County; and (4n) limestone about 325 feet (99.1 m.) above the unconformable base of the Cambrian in divide at the head of Jackson Creek (locally known as Sheep Creek), a creek flowing into Jackson Lake about 0.5 mile (0.8 km.) south of its northwestern corner, Teton Mountains, Grand Teton quadrangle (U. S. Geol. Survey), Uinta County; both in Wyoming.

(3g) Shales on the river bank 250 feet (76.2 m.) above the west end of the Denver and Rio Grande Railroad tunnel, Glenwood Springs, Garfield County, Colorado.

(329c) In Weber Canyon, about 2.5 miles (4 km.) northeast of Peterson, Morgan County; (30p) about 125 feet (38 m.) above the Cambrian quartzitic sandstones, on the north side of Ogden Canyon, about 1 mile (1.6 km.) above its mouth, east of Ogden, Weber County; and (30a) shale on north side of Big Cottonwood Canyon, 1 mile (1.6 km.) below Argenta, Wasatch Range, southeast of Salt Lake City, Salt Lake County; all in Utah.

(32y) Shales about 175 feet (53.3 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], in the Wasatch Mountains, 1 mile (1.6 km.) northwest of Geneva (Copenhagen), east of Brigham; (32p and 55e) Spence shale member of the Ute limestone, about 100 feet (30.5 m.) above the Brigham quartzite [Walcott, 1908f, p. 197], in Wasatch Canyon, east of Lakeview Ranch, 5 miles (8 km.) north of Brigham; and (329) *green shales in a cañyon about 7 miles (11.2 km.) north of Brigham (near the village of "Calls Fort" [Hague, 1877, p. 405])*; all in Boxelder County, Utah.

(31e and 54a) About 750 feet (228.6 m.) above the Brigham quartzite and 3,440 feet (1,048.5 m.) below the Upper Cambrian, in the shales forming 2a of the Ute limestone [Walcott, 1908f, p. 196], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum; (32d) shales about 150 feet (45.7 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], on the east side of the south fork of Paradise Dry Canyon (locally known as East Fork), east of Paradise; and (31z and 55t) about 350 feet (106.7 m.) above the Brigham quartzite, in the Ute limestone [Walcott, 1908a, p. 7], on west side of road 0.5 mile (0.8 km.) above the forks, Paradise Dry Canyon, east of Paradise; all east of Cache Valley, Cache County, Utah.

(32o) Shale about 325 feet (99 m.) above the Cambrian quartzitic sandstones, 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range; (3d) concretionary limestone about 100 feet (30.5 m.) above the Cambrian quartzitic sandstones, at Ophir, Oquirrh Range; (329e) shales in East Canyon, above Ophir, Oquirrh Range; (3c) shales about 75 feet (22.9 m.) above the Cambrian quartzitic sandstones, at Ophir, Oquirrh Range; and (32h and 32z) shales in a canyon on the west side of the Simpson Range, 4 miles (6.4 km.) south of Simpson Spring, about 20 miles (32.2 km.) west-southwest of Vernon; all in Tooele County, Utah.

(30d) About 1,020 feet (310.9 m.) above the Lower Cambrian and 3,400 feet (1,036.3 m.) below the Upper Cambrian in the limestone forming 1e of the Swasey formation [Walcott, 1908f, p. 182], at the head of Dome Canyon; and (31s) 490 feet (149.4 m.) above the Lower Cambrian and 3,925 feet (1,196.3 m.) below the Upper Cambrian in the pinkish argillaceous shale forming 1d of the Howell formation [Walcott, 1908f, p. 182], south side of Dome Canyon about 1 mile (1.6 km.) below the divide; both about 3 miles (4.8 km.) west-southwest of Antelope Springs, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah.

(31) Shales on the dump of the Chisholm mine; (333b [Pack, 1906, p. 295]) shales on the dump of the Half-moon mine; (333a [Pack, 1906, p. 295]) shales on the dump of the Himon mine; (333 [Pack, 1906, p. 295]) shales on the dump of the Abe Lincoln mine; (7k) shales in the dumps of the Half-moon and Chisholm mines, southwest slope of Ely Mountains; and (31u) shales on the west slope of the spur facing the main part of the Highland Range; all about 3 miles (4.8 km.) northwest of Pioche, Lincoln County, Nevada.

(90) Conasauga ("Coosa") shale, on Edwards farm, near Craigs Mountain, about 10 miles (16.1 km.) southeast of Center, Cherokee County; and (141a) limestone 0.25 mile (0.4 km.) west of the hotel at Montevallo, Shelby County; both in Alabama.

(14a) Sandstone of the Rome formation along First Creek Gap, 4 miles (6.4 km.) north-northeast of Knoxville [Keith, 1905, areal geology sheet], Knox County, Tennessee.

Lower Cambrian: (4v) About 200 feet (61 m.) above the unconformable base of the Cambrian and 75 feet (22.9 m.) above the top of the quartzitic sandstones in a shale which corresponds in stratigraphic position to shale No. 6 of the Dearborn River section [Walcott, 1908f, p. 202], on Gordon Creek, 6 miles (9.6 km.) from South Fork of Flathead River, Ovando quadrangle (U. S. Geol. Survey), Powell County, Montana.

(33i) About 100 feet (30.5 m.) above the Prospect Mountain quartzite in the shales of the Pioche formation [Walcott, 1908f, p. 171], 0.25 mile (0.4 km.) below the Maxfield mine, Big Cottonwood Canyon, west front of the Wasatch Mountains, southeast of Salt Lake City, Salt Lake County, Utah.

(30) Eight miles (12.8 km.) north of Bennetts Spring, on the west slope of the Highland Range, Lincoln County, Nevada.

Specimens that are somewhat doubtfully referred to *Obolus* (*Westonia*) *ella* occur at the following localities:

Middle Cambrian: (57y) About 1,900 feet (579 m.) above the Lower Cambrian and 3,050 feet (930 m.) below the Upper Cambrian, in the siliceous shales forming 2a of the Stephen formation [Walcott, 1908f, p. 211], on Mount Bosworth, north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide between British Columbia and Alberta, Canada.

(31d and 54l) About 500 feet (152.4 m.) above the Brigham quartzite and 3,700 feet (1,127.8 m.) below the Upper Cambrian, in the Spence shale member of the Ute limestone [Walcott, 1908f, p. 197], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County; (32n) shales about 725 feet (221 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], in the Wasatch Mountains, 1 mile (1.6 km.) northwest of Geneva (Copenhagen), east of Brigham, Boxelder County; and (11s) shales just above Simpson Spring, about 20 miles (32.2 km.) west-southwest of Vernon, on the stage road from Vernon to Fish Springs, Tooele County; all in Utah.

Obolus (Westonia) ella onaquiensis Walcott.

Plate XLIX, figures 6, 6a.

Obolus (*Westonia*) *ella onaquiensis* Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 67–68. (Discussed as below as a new variety.)

This variety is represented by a number of more or less imperfect specimens that at first sight might be placed with *Obolus* (*Westonia*) *ella* (Hall and Whitfield), but the character of the surface clearly distinguishes the two forms. In typical forms of *O.* (*W.*) *ella* the transverse striæ are more regular, while in this variety they are in the form of sharp, finely zigzag, transverse striæ much like the shells of the species from the Bighorn Mountains. This surface is formed by the interruption of very fine sharp ridges that curve from the umbo outward toward the sides and front of the shell like engine-turned striæ on a watch case.

This form derives its varietal name from its occurrence in the Onaqui Range of Utah.

Formation and locality.—**Middle Cambrian:** (33f) Shales about 400 feet (122 m.) above the Cambrian quartzitic sandstones, on the western slope of the high peak southwest of Lookout Pass, Onaqui Range, west of Vernon, Tooele County, Utah.

Obolus (Westonia) elongatus Walcott.

Plate LXIII, figures 8, 8a–d.

Obolus (*Westonia*) *elongatus* Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 68, Pl. VII, fig. 12. (Described and discussed as below as a new species. Fig. 12 is copied in this monograph, Pl. LXIII, fig. 8a.)

General form elongate oval, with the ventral valve acuminate and the dorsal valve elongate oval. Convexity unknown, as the shells are all flattened by compression.

The outer surface is marked by fine concentric lines of growth crossed by a series of finely denticulated, imbricating lines that start on each cardinal slope and extend obliquely forward across the median line, and then curve out toward the sides of the shell; minute rhomboidal spaces are formed over the posterior and central portions of the shell by the crossing of the oblique lines; the denticulated margin faces forward and is seen only on the thin epidermal layer, while the general system of oblique lines shows on both the outer layer and the next inner layer of the shell.

The shell is built up of several thin layers or lamellæ. The largest specimen of the ventral valve has a length of 9 mm.; width, 5 mm.; a dorsal valve 6 mm. long has a width of 4 mm. Nothing is known of the interior of these valves.

Observations.—This is a more elongate species than *Obolus* (*Westonia*) *bottnicus* Walcott and *O.* (*W.*) *finlandensis* Walcott. The oblique surface lines have the same general direction as those of the latter species, but they are finely denticulated on their front margin, and cross at the center at a greater angle.

Formation and locality.—**Middle Ordovician:** (105x) Gray, siliceous shales, just below a band of quartzitic sandstones, probably corresponding in position to the upper part of the Simpson formation of the Oklahoma section, Wasatch Canyon, east of Lakeview Ranch, about 5 miles (8 km.) north of Brigham, Boxelder County, Utah.

Obolus (Westonia) escasoni (Matthew).

Plate XLIX, figures 1, 1a–f.

Lingulella (*?*) *escasoni* Matthew, 1901, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 4, No. 19, pp. 270–273, Pl. V, figs. 1a–i. (Described and discussed as a new species. The specimens represented by figs. 1d and 1g are redrawn in this monograph, Pl. XLIX, figs. 1b and 1a, 1aa, respectively.)

Obolus (*Westonia*) *escasoni* (Matthew), Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 691. (Merely changes generic reference.)

Westonia escasoni Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 206–209, Pl. XVI, figs. 1a–i. (Copied from Matthew, 1901a, pp. 270–273, Pl. V, figs. 1a–i.)

General form ovate, with the ventral valve broadly subacuminate and the dorsal valve rounded oval in outline. The valves are moderately convex, the ventral being most prominent

toward the beak. The convexity gives a depth of about 1 mm. to shells 5 mm. in diameter. Surface marked by radiating striæ, concentric lines of growth, and fine, more or less undulating transverse striæ. When the thin outer layer of the shell is exfoliated, the next layer is marked by rather strong, radiating striæ and concentric striæ and lines of growth. The inner surface of the shell is strongly pitted, even over the visceral area, and the anterior and lateral margins are marked by the impressions of the fine canals of the vascular system. The character of the transverse lines is fully shown by Plate XLIX, figure 1f.

The shell is relatively thick, and formed of a very thin outer layer and several inner layers or lamellæ, which are more or less oblique to the outer layer. These layers are well shown by the posterior portion of Plate XLIX, figure 1a.

The shell is small, the largest not exceeding 6 mm. in length. The dorsal valve is slightly shorter than the ventral. The relative dimensions of the two valves may be seen by comparing figures 1 and 1b of Plate XLIX.

The details of the area of the ventral valve are not well shown by any specimens in the collection. The pedicle groove appears to have been well marked, and the area to have extended a short distance out on the cardinal slopes. The area of the dorsal valve is larger in proportion than usual when compared with that of the ventral valve. The striæ of growth cross it parallel to the anterior margin.

The interior of the ventral valve is shown by Plate XLIX, figure 1a, which beautifully preserves the central portion, and by the cast (fig. 1). The heart-shaped pit (x), so characteristic of *Obolus*, is clearly defined in figure 1a, where it strongly resembles the same space in *Obolus apollinis* Eichwald (Pl. VII). No traces of a median septum have been observed in the ventral valve, but in the dorsal valve the median ridge extends from back of the central muscle scars to the anterior lateral scars. A strong, pestle-shaped depression extends in the ventral valve from the area forward to the anterior margins of the visceral cavity. The visceral area of the dorsal valve is narrow, elongate, and extends forward to the anterior third of the valve.

Owing to the small size of the shell and the exfoliation along the margins, no one valve shows all of the muscle scars belonging to it. In Plate XLIX, figure 1a, the outside lateral, middle lateral, and central scars are beautifully defined, but the transmedian and anterior laterals have not been observed in the ventral valve. Many specimens show the anterior laterals and centrals of the dorsal valve, also the transmedian. The outside and middle laterals appear to be combined in one scar a little anterior to the transmedian. The umbonal and pedicle scars have not been observed.

Of the markings left on the shell by the vascular system the main or trunk canals are the most prominent. They are, however, rather indistinct in most examples of the dorsal valve and not specially prominent in the ventral valve. The channels occupied by the fine branches of the exterior lateral canals are well shown by Plate XLIX, figures 1a and 1c.

Observations.—I have made a very close examination of Matthew's type material, which he kindly sent to me for examination, but do not find the muscle scars of the ventral valve as shown in his figure 1g [Matthew, 1903, Pl. XVI]. On the contrary, as shown in my Plate XLIX, figure 1a, the outside and middle laterals and central muscle scars are arranged very much as in *Obolus*. It is exceedingly difficult to determine the exact position and size of the muscle scars, but with a strong magnifying glass and reflected light the dull surface of the point of attachment can often be determined. The peculiar arrangement of the muscle scars indicated in Matthew's figure [1903, Pl. XVI, fig. 1g] results from examining the specimen in a light which raises the ridges bounding the muscle scars so as to give the effect of transverse lines. I find that the scars are not placed in exactly the same position on the two sides, and that on the left side it is practically impossible to determine the outside laterals. In the study of such minute objects there will always be an opportunity for different interpretation, but with the experience I have had in the study of the Cambrian Brachiopoda, I think the position given the muscle scars in figure 1a is essentially correct. The characteristic transverse sculpture refers the species to *Westonia*. It is a beautiful shell and one of the most striking forms of this type from the Cambrian rocks.

The specific name is derived from "Escasonie," a local name for that part of Cape Breton in which the species occurs.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**325** [*Matthew, 1903, p. 208*]) *Arenaceous shales possibly from the horizon of the Peltura fauna (Division C3b), on McAdam shore;* and (**10r**)[a] arenaceous shales of Division C3a? of Matthew at McAdam shore; both on East Bay, east of Bras d'Or Lake, southeastern Cape Breton, Nova Scotia.

Middle? Cambrian: (**10o**)[a] Arenaceous shales in the railroad cut on the shore of Bras d'Or Lake, at Barachois; and (**11z**) sandstone on Big Ridge, 2 miles (3.2 km.) south of Marion Bridge, on the canal of John McDougald; both in southeastern Cape Breton, Nova Scotia.

OBOLUS (WESTONIA) EUGLYPHUS (Walcott).

Plate XLVIII, figures 1, 1a–f.

Obolus (*Lingulella*) *euglyphus* WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 402–403. (Described and discussed essentially as below as a new species.)

Obolus (*Westonia*) *euglyphus* WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 691. (Merely changes generic reference.)

General form ovate, with the ventral valve subacuminate, and the dorsal valve broad ovate in outline. There is some range of variation in the outline of the valves; this may be seen by comparing figures 1, 1b, and 1c of Plate XLVIII. The convexity of the valves is fairly strong and is nearly the same in each. A ventral valve 11 mm. in length has a width of 8 mm., convexity 1.5 mm.; and a dorsal valve 9 mm. in length has a width of 8 mm., convexity 1.5 mm.

The outer surface of the shell is marked by strong concentric lines and striæ of growth and a complex system of lamellose striæ of the type of those on *Obolus* (*Westonia*) *ella* (Hall and Whitfield). The striæ have a transverse direction, are irregular, and sometimes inosculate. They are somewhat coarser than those on the surface of *O.* (*W.*) *ella* (Pl. XLVII, fig. 1 l) and finer than those of *O.* (*W.*) *aurora* (Hall) (Pl. XLVI, figs. 1h and 1g). They are also less irregular than those of *O.* (*W.*) *ella*, and more so than those of *O.* (*W.*) *aurora*, the result being a surface character intermediate between those of the species mentioned. When the outer layer is exfoliated the surface of the inner layer is marked by numerous fine, radiating striæ (Pl. XLVIII, fig. 1b) and concentric lines of growth. The cast of the inner surface of the shell shows rather numerous papillæ that fill the pits or punctæ in the shell. The shell is strong and formed of a thin outer layer and several inner layers or lamellæ that are arranged very much as in *Lingulella acutangula* (Roemer) (Pl. XVII).

As shown by casts of the interior the cardinal area of the ventral valve is rather long and well extended out on the cardinal slopes. It is divided at the center by a cast of a strong, rather deep pedicle furrow, and about three-fifths of the distance between the pedicle furrow and the lateral margin by a sharp, narrow flexure line. The striæ of growth cross the area parallel to its base. Only a few traces of them are preserved in the pedicle furrow. The area formed a thin shelf between the pedicle groove and the lateral margins, the undercut extending far back under the area as in *L. acutangula*. This is shown in the cast by a thin projection of the embedding rock over the area (Pl. XLVIII, figs. 1c and 1d). The area of the dorsal valve is lower and less prominent. It arches forward at the median line and extends well out on the cardinal slopes.

The cast of the visceral cavity (v) of the ventral valve includes the heart-shaped pit (x) and a slight trace of the trapezoidal area, in which the central muscle scars and the middle and outside lateral muscle scars occur. There are no traces of a median septum in the ventral valve, and it is only slightly indicated in one specimen of the dorsal valve. This is owing, however, more to the condition of preservation of the specimen than to the character of the septum. No muscle scars are clearly defined in either valve. Of the vascular system the main or trunk sinuses are fairly well shown in the ventral valve (Pl. XLVIII, figs. 1c and 1d), but less so for the dorsal valve (Pl. XLVIII, fig. 1e).

Observations.—This form has the general shape of *Lingulella acutangula* (Roemer), but differs in being more ovate; it also differs in the arrangement of the markings on the interior

[a] The specimens from Localities **10o** and **10r** are somewhat doubtfully referred to this species.

of the valves, particularly the dorsal. In *Obolus* (*Westonia*) *euglyphus* the traces remaining on the casts indicate a close resemblance to *O.* (*W.*) *chuarensis* (Walcott), and the surface ornamentation is of the same character. Attention has been called to the character of the surface, which is intermediate between that of *O.* (*W.*) *ella* (Hall and Whitfield) (p. 456) and *O.* (*W.*) *aurora* (Hall) (Pl. XLVI).

This species differs from *Lingulella lineolata* (Walcott) in its surface characters, thickness of shell, and usually in outline; it is also usually a larger species, although a few examples of *L. lineolata* approach it in size. From *O.* (*W.*) *chuarensis* it differs in being much more elongate and proportionately more ovate in outline.

Formation and locality.—**Middle Cambrian**: (74c) "Tonto" sandstone, at the head of Lava Canyon; and (74) *sandstones about 300 feet (91.4 m.) above the base of the Tonto group, at the head of Nunkoweap Valley*; both in the Grand Canyon of the Colorado, Arizona.

Obolus (Westonia) finlandensis Walcott.

Plate XLVIII, figures 3, 3a–b.

Obolus (*Westonia*) *finlandensis* Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 611–612. (Described and discussed as below as a new species.)

General form elongate ovate, with the ventral valve subacuminate and the dorsal valve ovate in outline. Convexity of the two valves moderate. A ventral valve 11 mm. in length has a convexity of about 1.25 mm., and a dorsal valve 8 mm. in length has a convexity of 1 mm. above the plane of the margin.

The outer surface of the shell is marked by concentric lines of growth with very fine interstitial striæ. The latter are crossed by fine, radiating striæ that are interrupted more or less by the concentric lines of growth. In addition to the concentric and radiating striæ there is a series of imbricating lines that are slightly oblique to the longitudinal axis of the shell. These lines terminate at right angles to the margins, curving inward and backward apparently to the opposite side. This type of ornamentation is much like that of several species of *Westonia*, except that it is somewhat more complicated.

The cast of the interior of the shell shows the interior surface to have been marked by scattered punctæ that had a tendency to gather concentrically on the lines of growth. A few rather strong radiating striæ also occur outside of the visceral area.

The shell is rather thick. It is formed of a thin outer layer and several inner layers or lamellæ that are more or less oblique to the outer surface and marked near the front margin by fine radiating striæ. The largest specimen has a length of 11 mm., with a width of 7 mm. A dorsal valve of the same width has a length of 8 mm.

The area of the ventral valve is unknown. That of the dorsal valve is strongly defined and extends well forward on the cardinal slopes. It is marked by transverse striæ of growth parallel to the base.

The only interior markings known are in the dorsal valve. These indicate the course of the main vascular sinus, and the size and length of the median ridge, also the position of the central muscle scars.

Observations.—The oblique, imbricating lines on the outer surface of this species relate it closely to *Obolus* (*Westonia*) *bottnicus* (Wiman) and *O.* (*W.*) *wimani* Walcott. The two specimens showing the outer shell are unfortunately slightly worn along the median line, so that it is not possible to trace the growth of the oblique, imbricating lines entirely across the shell. In form the shell resembles *Lingulella acutangula* (Roemer).

Formation and locality.—**Middle Cambrian**: (311x) Compact, fine-grained, quartzitic sandstone at Saltvik, Åland Island, Finland, Russia.

Obolus (Westonia) iphis Walcott

Plate XLIX, figures 4, 4a–d.

Obolus (*Westonia*) *iphis* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 336. (Described as below as a new species.)

The general form of this shell is well shown by the illustrations. It differs from all other species of *Westonia* in having a more elongate and acuminate ventral valve and in the presence

of a marked mesial depression on the dorsal valve. The shell is rather thin and made up of several very thin layers or lamellæ. The outer surface is marked by fine radiating striæ, concentric striæ and lines of growth, and fine, more or less undulating, transverse lines that cross both the radiating and concentric lines. The transverse lines appear to be the edges of slightly elevated imbricating lamellæ of the shell.

FORMATION AND LOCALITY.—**Lower Ordovician:** (**201a**) *Pogonip limestone, east slope of the ridge east of Hamburg Ridge, Eureka district* [*Hague, 1892, Atlas*], *Eureka County, Nevada.*

Upper Cambrian: (**64**) Limestone near the Bullwhacker mine, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

(**54j**) About 700 feet (213.4 m.) above the Middle Cambrian and 525 feet (160 m.) below the top of the Upper Cambrian, in the arenaceous limestone forming 2c of the St. Charles formation [Walcott, 1908f, p. 192], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

OBOLUS? (WESTONIA?) LAMELLOSUS (Barrande).

Plate XII, figures 7, 7a–d.

Lingula lamellosa BARRANDE, 1879, Systême silurien du centre de la Bohême, vol. 5, Pl. CVI, figs. I: 1–5; Pl. CXI, figs. IX: 1–3. (Not described, but figured as a new species. Pl. CVI, figs. I: 2A, I: 3f, and Pl. CXI, figs. IX: 2A; IX: 1A, and IX: 1f are copied in this monograph, Pl. XII, figs. 7, 7a–d, respectively.)

Obolus (*Westonia?*) *lamellosus* (Barrande), WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 691. (Merely changes generic reference.)

This species appears to be the Bohemian Lower Ordovician representative of *Obolus* (*Westonia*) *stoneanus* (Whitfield) of the Upper Mississippi Valley Middle Cambrian fauna. The two forms agree in relative size and proportions and in type of surface ornamentation. This may be seen by comparing figures 2, 2a–g, Plate XXVIII, with figures 7, 7a–d, Plate XII. Another point of similarity is that both species are very abundant in the localities in which they occur.

The principal differences to be noted are that *O.?* (*W.?*) *lamellosus* has apparently a thicker and stronger shell than *O.* (*W.*) *stoneanus*. This, however, may be due to the fact that all the specimens of the latter species are more or less flattened in the shaly sandstone, and that the shell substance has been largely removed by solution. It is on account of the resemblance of the two forms that Barrande's species is referred to the genus *Obolus* and subgenus *Westonia*, despite the absence of any knowledge of the area or the interior vascular markings or muscle scars.

It is hoped that the paleontologists of Bohemia will take up the study of this species and others that have been referred to *Obolus*, in order to establish clearly their generic relations.

FORMATION AND LOCALITY.—**Lower Ordovician:** (**303**1 [Barrande 1879b, Pl. CVI]) Étage d1, Libetschov, Bohemia, Austria-Hungary.

OBOLUS (WESTONIA) NOTCHENSIS Walcott.

Plate LXIII, figure 9.

Obolus (*Westonia*) *notchensis* WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 69, Pl. VII, fig. 13. (Discussed as below as a new species. Fig. 13 is copied in this monograph, Plate LXIII, fig. 9.)

This species is represented by two specimens of the ventral valve that have the general outline of *Lingulella ampla* (Owen) (Pl. XXVIII, figs. 1a and 1f). The exterior surface is marked by concentric lines of growth and transverse, irregular, imbricating lines much like those of *Obolus* (*Westonia*) *stoneanus* (Whitfield) (Pl. XXVIII, fig. 2) and *O.* (*W.*) *iphis* (Pl. XLIX, figs. 4a–c). The form of the valve differs from that of the latter species.

The largest specimen has a length of 11 mm., with a maximum width of 9 mm.

The specific name is derived from Notch Peak, Utah, on which the species occurs.

FORMATION AND LOCALITY.—**Lower Ordovician:** (**105t**) Thin-bedded, bluish-gray limestone [Walcott, 1908f, p. 173 and Pls. XIII and XIV], at the summit of Notch Peak, House Range, Millard County, Utah.

OBOLUS (WESTONIA) ROGERSI (Walcott).

Plate XLII, figures 2, 2a–d.

Lingula prima ROGERS [not CONRAD MS., HALL], 1861, Proc. Boston Soc. Nat. Hist., vol. 7, p. 390. (Mentioned.)

Lingula antiqua ROGERS [not EMMONS], 1861, idem, p. 390. (Mentioned.)

Obolus (*Lingulella*) *rogersi* WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 413–415. (Described and discussed essentially as below as a new species.)

Lingulella rogersi (Walcott), GRABAU, 1900, Occas. Papers Boston Soc. Nat. Hist., No. 4, vol. 1, pt. 3, pp. 624–625, Pl. XXXI, fig. 4. (Described and discussed.)

Obolus (*Westonia*) *rogersi* WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 691. (Merely changes generic reference.)

General form elongate ovate, with the ventral valve subacuminate and the dorsal valve ovate in outline. There is considerable range of variation in the outline of the valves, owing largely to distortion apparently produced by movement of the matrix. The convexity of the valves is fairly strong and nearly the same in both, except that the dorsal valve curves more abruptly inward toward the beak.

The outer surface of the shell usually adheres to the matrix, but, in three specimens, portions of it are preserved which show that it is of essentially the same character as that of *Obolus* (*Westonia*) *stoneanus* (Pl. XXVIII). The surface is formed by very fine concentric lines and striæ of growth crossed transversely by strong, undulating, slightly lamellose lines (Pl. XLII, figs. 2 and 2d). When the outer layer is exfoliated the inner layers are marked by concentric lines of growth and fine radiating striæ. This is also the character of the inner surface, so far as can be determined from the specimens in the collection. The shell is rather thick and built up of a thin outer layer and several inner layers or lamellæ, the latter becoming increasingly numerous toward the front. The largest dorsal valve in the collection has a length of 13 mm. with a width of 11 mm., and a smaller ventral valve with a length of 12 mm. has a width of 9 mm. The dimensions of most of the specimens in the collection average less than those here given.

The area of the ventral valve is relatively short for a species of this type. It is divided midway, as seen in the cast, by a strong pedicle furrow. Owing to the imperfection of the material, none of the specimens show flexure lines or striæ of growth. The area of the dorsal valve is short and extends but a short distance on either side of the median line. The cast of the interior of the ventral valve is very much like that of the interior of *Obolus cyane* (Pl. XVII). It has the same median ridge and the transverse trapezoidal area which includes the central, middle lateral, and outside lateral muscle scars. The main vascular sinuses are indicated by slight ridges (Pl. XLII, figs. 2a and 2b). The cast of the interior of the dorsal valve shows a narrow median septum, two central muscle scars of average size, situated a short distance back of the center of the shell, and two small anterior lateral scars, located some distance in advance of the center, which give an elongated visceral cavity somewhat like that of *Lingulella hayesi* (Pl. XXV) of the Middle Cambrian and *Obolus lamborni* (Pl. XXII) of the Upper Cambrian.

Observations.—The external form of the more elongate specimens of this species is very much like that of *Lingulella acutangula* (Roemer) (Pl. XVII). When compressed laterally it occasionally has the form of *Lingulella* (*Lingulepis*) *acuminata* (Conrad). It is distinguished, however, from all described species of *Westonia* known to me by its highly characteristic surface ornamentation. *Obolus* (*Westonia*) *stoneanus* (Pl. XXVIII) has the same type of surface, but it differs from the latter in being a much more elongate shell.

The material described in this monograph was collected by Prof. N. S. Shaler and Mr. J. B. Woodworth from the pebbles on the beach on the northern shore of Marthas Vineyard, Massachusetts, and at several points along the shores of Narragansett Bay.

The first notice we have of these fossiliferous pebbles is that by W. B. Rogers, who [1861, p. 389] announced the discovery, by Norman Easton, of pebbles carrying fossils of the Potsdam fauna in the Carboniferous conglomerate north of Fall River, Massachusetts. In 1875 [p. 100] Rogers announced the discovery of impressions, suggestive of the fossil Lingulas mentioned by him from Fall River, in the pebbles in the conglomerate at Newport, Rhode Island. He thought that the pebbles were derived from rocks probably closely connected in time with the Braintree *Paradoxides* zone.

Among the material sent by Professor Shaler I found the remains of a large Linguloid brachiopod, which appears to be identical with *Obolus* (*Lingulobolus*) *affinis* (Billings), from the Lower Ordovician rocks of Newfoundland. The material is somewhat imperfect, but I

do not know of any other large brachiopod of this type from the Cambrian or Ordovician rocks. The reference to the Lower Ordovician is made by reason of the presence of this *Lingulobolus*.

The specific name is given for Mr. W. B. Rogers, who first called attention to the species.

FORMATION AND LOCALITY.—**Lower Ordovician:** (**326**) Limestone pebbles on the beach on the northern shore of Marthas Vineyard; and (**326a** [Grabau, 1900, p. 613]) limestone pebbles in a Carboniferous conglomerate north of Fall River, Bristol County; both in Massachusetts.

(**343** [*Rogers, 1875, p. 11, and U. S. Nat. Mus.*]) *Limestone pebbles on the beach near Newport and at several points along the shores of Narragansett Bay, Rhode Island.*

(**114b**) Sandstone 1 mile (1.6 km.) north of Lance Cove, Great Belle Island, Conception Bay, Newfoundland.

OBOLUS (WESTONIA) STONEANUS (Whitfield).

Plate XXVIII, figures 2, 2a–g; Plate XLIX, figures 2, 2a.

Lingula aurora var. HALL, 1863, Sixteenth Ann. Rept. New York State Cab. Nat. Hist., pp. 127–128, Pl. VI, figs. 6–8. (Described and discussed.)

Lingula aurora var. HALL, 1867, Trans. Albany Inst., vol. 5, pp. 104–106, Pl. I, figs. 6–8. (Copy of preceding reference.)

Lingulella aurora var. HALL, 1873, Twenty-third Ann. Rept. New York State Cab. Nat. Hist., pp. 244–245, Pl. XIII, fig. 5. (Mentions change of genus. Fig. 5 is drawn from the same specimen as Hall, 1863, Pl. VI, fig. 7.)

Lingulella stoneana WHITFIELD, 1882, Geology of Wisconsin, vol. 4, pp. 344–345, Pl. XXVII, figs. 6 and 7. (Characterized and discussed as a new species.)

Lingulella stoneana Whitfield, HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, Pl. II, figs. 9–11. (No text reference. Figs. 9 and 11 are copied from Hall, 1863, Pl. VI, figs. 7 and 8, respectively; and fig. 10 from Hall, 1873, Pl. XIII, fig. 5.)

Lingulella stoneana Whitfield, WELLER, 1903, Geol. Survey New Jersey, Rept. Paleontology, vol. 3, p. 112, Pl. I, fig. 6. (Described and discussed. The specimen represented by fig. 6 is redrawn in this monograph, Pl. XLIX, figs. 2 and 2a.)

Obolus (*Westonia*) *stoneanus* (Whitfield), WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 691. (Merely changes generic reference.)

In form *Obolus* (*Westonia*) *stoneanus* (Pl. XXVIII) approaches quite closely to the more rounded shells of *Lingulella ampla* (Owen), except that in the dorsal valve the posterior lateral slopes are broadly rounded, giving a subelliptical outline to the valve. The original convexity of the valves is not preserved, but it appears to have been moderate, like that of *Lingulella ampla*. A large ventral valve from Prairie du Sac has a length of 15 mm., with a maximum width of 11 mm. An associated dorsal valve, 10 mm. wide, has a length of 11.5 mm. The surface of the shell is strongly characteristic. It is formed by very fine concentric lines or striæ of growth crossed transversely by strong, undulating slightly lamellose lines (Pl. XXVIII, fig. 2d, and Pl. XLIX, fig. 2a). The margins of the inner surface of the shell show fine radiating lines. All of the large number of specimens in the collection are flattened in the shaly sandstone, and there is usually little left of the substance of the shell to afford a basis for an opinion of the form or thickness. A careful study of the material, however, leads to the conclusion that the valves were moderately convex and comparatively thin. In casts of the interior the concentric striæ and transverse lamellose lines are almost invariably strongly marked, and no traces of the interior muscle scars or markings are preserved.

The area of the ventral valve, as seen in a cast, is divided midway by the cast of the strongly marked pedicle groove and, on each side and well out toward the margin, by the flexure lines. The few striæ of growth preserved cross the area parallel to its base. On the dorsal valve the area is short, broad, and slightly arched forward near the center; the flexure lines are fairly well preserved in a compressed cast of the shell. No muscle scars or vascular markings have been observed on the interior casts of the ventral valve. A dorsal valve shows the central muscle scars (h) and the base of the main vascular sinuses (vs) (Pl. XXVIII, fig. 1h).

Observations.—This species was separated as a variety of *Obolus* (*Westonia*) *aurora* by Professor Hall [1863, p. 127]. Later [1882, p. 344], Professor Whitfield, finding that its peculiarities persisted in specimens found at localities where *O.* (*W.*) *aurora* did not occur, gave it a specific name. The peculiar surface ornamentation clearly distinguishes it from other species

of the genus except *O.* (*W.*) *aurora*, from which it differs in having a more elongate form and in the fact that the surface markings, though of the same type, vary in being much coarser and in having longer undulations. (Compare Pl. XXVIII, fig. 2d, with Pl. XLVI, fig. 1h.)

The form found by Stuart Weller [1900, p. 112] in the Upper Cambrian sandstones of northern New Jersey is illustrated on Plate XLIX, figures 2, 2a.

The specific name was given for Mr. R. E. Stone [Whitfield, 1882, p. 345].

FORMATION AND LOCALITY.—**Upper Cambrian**: (**85x**) Upper beds of the "St. Croix sandstone" at Mazomanie, Dane County; (**81b**) "St. Croix sandstone" near Devils Lake, Sauk County; (**328m**) sandstone 1 mile (1.6 km.) south of Osceola, Polk County; (**328f** [Hall, 1863, p. 128]) sandstone at the falls of St. Croix River, Polk County; and (**85** and **85s**)[a] "*St. Croix sandstone*" *at Prairie du Sac, Sauk County;* all in Wisconsin.

(**11c**) Hardyston quartzite [Weller, 1903, pp. 110 and 112], O'Donnell and McManniman's quarry, Newton, Sussex County, New Jersey.

(**327**) Arenaceous limestone east of Gold Camp; (**327a**) arenaceous limestone about 500 feet (152 m.) above the base of the Cambrian in McKinley Canyon; (**327b**) arenaceous limestone near the base of the section on the south side of Cerro Cuchillo; and (**327c**) arenaceous limestone in the Caballos Mountains (exact locality unknown); all in the Caballos Mountains, Sierra County, New Mexico.

OBOLUS (WESTONIA) THEMIS Walcott.

Plate XI, figures 2, 2a–c.

Obolus (*Westonia*) *themis* WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 336–337. (Described and discussed as below as a new species.)

General form subsemicircular, with the ventral valve subacuminate and the dorsal valve broadly ovate in outline. Valves rather strongly convex. Surface of the shell marked by strong concentric lines of growth with finer intermediate striæ; in addition there are very fine, irregular, raised, more or less transverse striæ that inosculate, forming a minutely papillose or granular surface much like that of *Obolus* (*Westonia*) *ella* (Pl. XLVII). It often occurs that the outer surface has been removed by attrition in the sand, so that the shell has a smooth polished surface. Owing to the condition of preservation the markings of the inner layers are not preserved. The shell is strong and thick in advance of the center. It is made up of the thin outer surface layer and several inner layers or lamellæ that in the posterior portions are slightly oblique to the outer surface. After the shell has attained a size of 2 or 3 mm. the lamellæ are more oblique to the outer surface and form a thick, strong shell, the outer edges of which often produce a rather rough surface. This is shown by the figures illustrating the species.

The largest ventral valve in the collection has a length and breadth of 10 mm.; a dorsal valve 10 mm. in length has a width of 11 mm. The only interior portions of the shell known are on a fragmentary ventral valve in which the visceral area does not reach the center, and the main vascular sinuses are about halfway between the center and the lateral margins of the valve.

Observations.—The general form of the shell is much like that of *Obolus loperi* (Pl. IX). It differs from the latter in surface characters.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**17c**) Sandy limestone 235 feet (71.6 m.) above the "Tonto" sandstone, Grand View trail, north of Last Chance copper mine, south side of the Grand Canyon of the Colorado, Arizona.

OBOLUS (WESTONIA) WASATCHENSIS Walcott.

Text figures 41A–F, page 467; Plate XLIX, figures 5, 5a.

Obolus (*Westonia*) *wasatchensis* WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 69–70, Pl. VIII, figs. 1 and 1a. (Discussed as below as a new species. Figs. 1 and 1a are copied in this monograph as figs. 41A and 41D.)

This species is founded on some large shells that differ from *Obolus* (*Westonia*) *ella* (Hall and Whitfield) (Pl. XLVII) in attaining a larger size and greater proportional width and in

[a] 85s is the type locality, though the specimens in the United States National Museum to which that number is assigned were collected much later than the type specimens.

having the surface marked by radiating lines that extend from the umbo with a gentle curvature toward the sides and front of the shell, so as to terminate at right angles to the margin, very much as in *Obolus* (*Westonia*) *finlandensis* (Pl. XLVIII, figs. 3 and 3a).

In the Blacksmith Fork section of the Middle Cambrian terrane in the Wasatch Mountains of northern Utah *O.* (*W.*) *wasatchensis* occurs 1,590 feet higher in the section than *O.* (*W.*) *ella.*

The specific name is derived from its occurrence in Wasatch Canyon, Utah.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**34u**) Shales about 950 feet (289.6 m.) above the Cambrian quartzitic beds, 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range, Tooele County; and (**33t**) shale about 1,500 feet (457.2 m.) above the Brigham quartzite, 1 mile (1.6 km.) northwest of Geneva (Copenhagen), east of Brigham, Boxelder County; both in Utah.

(**54q**) *Drift block supposed to have come from the horizon of Locality 32x;* (**32x**) about 1,700 feet (518.2 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], in shales correlated with the shales forming 2d of the Bloomington formation in Blacksmith Fork Canyon [Walcott, 1908f, p. 195]; and (**33j**) about 2,300 feet (701 m.) above the Brigham quartzite; all in Wasatch Canyon, east of Lakeview Ranch, 5 miles (8 km.) north of Brigham, Boxelder County, Utah.

(**54h**) About 3,140 feet (957.1 m.) above the Brigham quartzite [Walcott, 1908a, p. 8] and 1,050 feet (320 m.) below the Upper Cambrian in the limestones forming 1a of the Bloomington formation [Walcott, 1908f, p. 194]; and (**54k**) about 2,100 feet (640 m.) above the Lower Cambrian and 2,100 feet (640 m.) below the Upper Cambrian in the shales forming 2d of the Bloomington formation [Walcott, 1908f, p. 195]; both in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

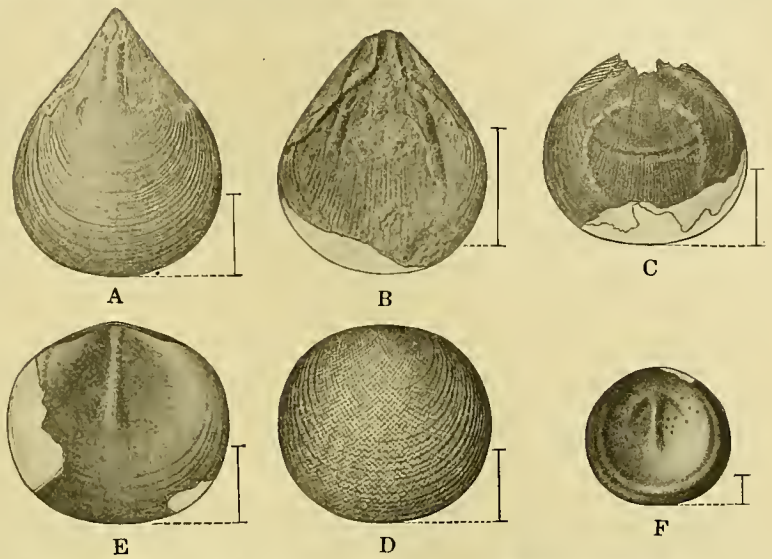

FIGURE 41.—*Obolus* (*Westonia*) *wasatchensis* Walcott. A, Elongate ventral valve, the type specimen (U. S. Nat. Mus. Cat. No. 51733a). B, Interior view of an elongate ventral valve (U. S. Nat. Mus. Cat. No. 51737a). C, Interior of a broken, flattened ventral valve (U. S. Nat. Mus. Cat. No. 51734b). D, Exterior of dorsal valve (U. S. Nat. Mus. Cat. No. 51734a). E, Interior of a flattened dorsal valve (U. S. Nat. Mus. Cat. No. 51734c). F, Interior of a dorsal valve (U. S. Nat. Mus. Cat. No. 51734d).

The specimens represented by figures 41A and 41B are from Localities **54q** and **55d**, respectively; and those represented by figures 41C–F are from Locality **54k**. Figures 41A and 41D are copied from Walcott [1908d, Pl. VIII, figs. 1 and 1a, respectively].

(**55d**) About 2,000 feet (609.6 m.) above the Cambrian quartzitic beds, in a shale which is probably to be referred to the Bloomington formation [Walcott, 1908a, p. 7], on the south side of Twomile Canyon near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

OBOLUS (WESTONIA) WIMANI Walcott.

Plate XLVIII, figures 5, 5a–b.

Lingula? sp. No. 1, WIMAN, 1902, Bull. Geol. Inst. Univ. Upsala, vol. 6, pt. 1, No. 11, p. 51, Pl. II, fig. 36. (Locality mentioned.)

Lingulella? sp. No. 1, WIMAN, 1902, idem, p. 52, Pl. II, fig. 30. (Locality mentioned. The specimen represented by fig. 30 is redrawn in this monograph, Pl. XLVIII, fig. 5.)

Lingulella? sp. No. 2, WIMAN, 1902, idem, p. 52, Pl. II, fig. 31. (Locality mentioned. The specimen represented by fig. 31 is redrawn in this monograph, Pl. XLVIII, fig. 5a.)

Lingulella? sp. No. 7, WIMAN, 1902, idem, p. 52, Pl. II, fig. 32. (Locality mentioned. The specimen represented by fig. 32 is redrawn in this monograph, Pl. XLVIII, fig. 5b.)

Obolus (*Westonia*) *wimani* WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 337. (Discussed essentially as below as a new species.)

The general form of this species is not unlike that of *Obolus* (*Westonia*) *bottnicus* (Wiman) (Pl. XLVIII). The cardinal slopes of the ventral valve are more rounded, which makes the valve broader near the center. All of the specimens are also smaller. The surface markings

are of the same character as those of *Obolus* (*Westonia*) *finlandensis* Walcott (Pl. XLVIII) and *O.* (*W.*) *bottnicus*.

It is not improbable that with the discovery of a large series of specimens the three species may be combined, or *O.* (*W.*) *bottnicus* and *O.* (*W.*) *wimani* placed as varieties of *O.* (*W.*) *finlandensis*.

For reference to the geological horizon of bowlders on Eggegrund Island, similar to the ones containing this species, see description of *O.* (*W.*) *bottnicus*, page 454.

The specific name is given for Dr. Carl Wiman, of the University of Upsala.

FORMATION AND LOCALITY.—**Middle? Cambrian:** (**311c**, **311g**, and **311i**)[a] *Drift bowlders of bituminous sandstone, Nos. 7, 16, and 27* [*Wiman, 1902, p. 57*], *on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg, Sweden.*

(**311t**) Drift bowlder of mottled calcareous sandstone [Wimau, 1902, p. 57], at Öfverby, parish of Jomala, Åland Island, Finland, Russia.

OBOLUS (WESTONIA) sp. undt. a.

Fragments of a species of *Obolus* with a very minutely reticulated surface occur in association with *Cyrtoceras cambria* Walcott and suggest *Obolus* (*Westonia*) *ella*, except that the surface ornamentation is so minute that it can only be seen with a strong lens. The fragments indicate a shell about the size of *O.* (*W.*) *ella*.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**C56**) Lower part of Chaumitien limestone, 25 feet below the top of Pagoda Hill [Blackwelder, 1907a, p. 42 (part of last list of fossils)], 1 mile (1.6 km.) west of Tsiuan, Shantung, China.

OBOLUS (WESTONIA) sp. undt. b.

Fragments of a shell showing the characteristic surface ornamentation of *Westonia* occur in the Ordovician limestone, Eureka district, Nevada. The shell must have been at least as large as *Obolus* (*Westonia*) *stoneanus* (Whitfield), but the material is too imperfect for identification.

FORMATION AND LOCALITY.—**Passage beds** between the Upper Cambrian and the Ordovician: (**205**) siliceous limestone on Roundtop Mountain, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

Genus LINGULELLA Salter.

[Lingula.]

Tellinomya McCOY [not HALL], 1854, British Paleozoic Fossils, p. 274. (Described from distorted specimens of *Lingulella davisi* (McCoy).)

Lingulella SALTER, 1866, Mem. Geol. Survey Great Britain, vol. 3, p. 333. (Described and discussed as a new genus.) "The name *Lingulella* was first introduced about 1861, with the late Dr. S. P. Woodward's full consent; and the name appears at page 9 of Sir Roderick Murchison's address to the geological section of the British Association, Manchester, 1861," but was not described (see Davidson, 1866, p. 55).

Lingulella Salter, DAVIDSON, 1866, British Fossil Brachiopoda, vol. 3, pt. 7, No. 1, p. 55. (Original description copied and *Lingulella* discussed as either a genus or subgenus.)

Lingulella Salter, DAVIDSON, 1868, Geol. Mag., vol. 5, p. 304. (Genus discussed.)

Lingulella Salter, DALL, 1870, Am. Jour. Conchology, 2d ser., vol. 6, pt. 2, pp. 153 and 159. (Described.)

Lingulella Salter, MEEK, 1871, Proc. Acad. Nat. Sci. Philadelphia for 1871, vol. 23, pp. 186–187. (Notes on genus in discussion of "*Lingulella lamborni*.")

Lingulella Salter, DALL, 1877, Bull. U. S. Nat. Mus. No. 8, p. 44. (Mentioned.)

Lingulella Salter, ZITTEL, 1880, Handbuch der Palæontologie, Bd. 1, Abth. 1, pp. 663–664. (Described in German.)

Lingulella Salter, SALTER and ETHERIDGE, 1881, Mem. Geol. Survey Great Britain, vol. 3, 2d ed., p. 537. (Copy of Salter, 1866b, p. 333.)

Lingula (*Lingulella*) Salter, OEHLERT, 1887, Manuel de conchyliologie, by Fischer, p. 1261. (Described in French.)

Lingulella Salter, BORNEMANN, 1891, Nova Acta Acad. Cæs. Leop. Carol. Germanicæ Naturæ Curiosorum, Bd. 56, No. 3, pp. 435–437. (Discussed in German.)

Lingulella Salter, HALL and CLARKE (in part), 1892, Eleventh Ann. Rept. State Geologist New York for 1891, pp. 232–233. (Described. *Lingulella davisi* is given as the type, but as a generic illustration *Botsfordia cælata* is figured on Pl. III.)

Lingulella Salter, HALL and CLARKE (in part), 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, pp. 548–549. (Copy of preceding reference.)

[a] **311c** is the type locality.

Lingulella Hall and Clarke (in part), 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 55–59. (Original description copied and genus discussed. *Lingulella davisi* is given as the type, but figures of *Obolus* (*Westonia*) *ella* accompany the text and as a generic illustration *Botsfordia cælata* is figured on Pl. II. Species belonging with other genera are also mentioned as belonging to *Lingulella*.)

Obolus (*Euobolus*) Mickwitz (in part), 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, p. 129. (Described in German.)

Obolus (*Lingulella*) (Salter), Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 390–392. (Discussed.)

Lingulella Salter, Matthew, 1899, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 3, No. 18, p. 201. (Characterized in discussion of *Palæobolus*, see p. 471, for copy.)

Obolus (*Lingulella*) (Salter), Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 683. (Characterized.)

Eoobolus Matthew, 1902, Trans. Roy. Soc. Canada for 1902, 2d ser., vol. 8, sec. 4, No. 3, p. 97. (Characterized without reference to Mickwitz and without any indication of the fact of its being intended as a new subgenus; see Matthew, 1903, p. 135.)

Lingulella Salter, Matthew, 1902, idem, p. 103. (Nova Scotia representatives mentioned.)

Leptobolus Matthew [not Hall], 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 105–106. (Described, see p. 472 for copy.)

Lingulella Salter, Matthew, 1903, idem, p. 116. (Discussed.)

Obolus (*Eoobolus*) Matthew, 1903, idem, p. 135. (Characterized as a new subgenus.)

Lingulella Salter, Delgado, 1904, Communicações Commissão Serviço Geol. Portugal, tome 5, fasc. 2, p. 367. (Discussed in French.)

Not *Lingulella* Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 192. (Described, but one of the species referred to belongs with *Obolus* (*Westonia*) and the other is the type of that subgenus.)

Lingulella Salter, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 144. (Classification of genus.)

Type of genus.—Lingula davisi McCoy.

Valves subequal, equilateral; elongate ovate, broad ovate, or subtriangular in outline. Ventral valve usually subacuminate, with a distinct area, pedicle groove, and flexure lines. Dorsal valve somewhat shorter, less acuminate, and with a less clearly marked pedicle groove on the shorter area. Beaks terminate at the margin of the areas, which are usually in the plane of the margins of the valves; the areas, which vary in size and shape in the different species, are usually more or less triangular; in the ventral valve they may be so shortened and arched as to nearly lose this marked form; the areas of the dorsal valve also vary in their form length, and extension on the cardinal slopes.

Shell substance calcareocorneous; structure consists of a thin outer surface layer and numerous inner layers or lamellæ that are subparallel to the surface over the posterior portions of the shell and more or less oblique to it over the central, lateral, and anterior portions; the short oblique layers usually form the inner flattened rim of the valves which is frequently seen in the casts (Pl. XVII, fig. 1i). Surface of shell marked by fine concentric striæ and lines of growth, and in some species finely inosculating, lamellose striæ; also, in most if not all species, radiating striæ and lines.

The visceral area (splanchnocœle [Mickwitz, 1896]) is usually confined to the central and posterior portions of the ventral valve, but it may extend far into the brachial area (brachiocœle [Mickwitz, 1896]) (Pl. XVII, fig. 1c); in the dorsal valve it extends farther forward than in the ventral valve of the same species; in both valves it may range from the posterior third of the shell forward to the anterior third, and in the dorsal well into the latter; in both valves the visceral area extends back to the base of the areas where it is bounded exteriorly by the flexure lines (lines of folding of the area lamellæ).

A narrow median ridge or septum is frequently observable in the dorsal valve, but with the exception of what may be considered as indicating its probable presence in one specimen of a ventral valve of *Lingulella davisi* (McCoy) (Pl. XXXI, fig. 6f), no traces of a septum have been observed in the ventral valve of any of the species that I have studied. The main vascular sinuses vary in size, direction, and length in the various species; in all they begin in front of the area at the median line and extend forward and outward across the parietal band into the central-lateral and anterior parts of the brachiocœle. The impressions of the secondary vascular canals are rarely preserved, but the few traces observed indicate that they were numerous and extended toward the peripheral canal and into the middle of the shell in the direction necessitated by the arrangement of the main sinuses and the boundaries of the visceral area.

In the anterior portion of the visceral area of the dorsal valve of some species the "heart-shaped pit" of *Obolus* is distinctly marked (Pl. XVII, fig. 1f). It is rarely so well shown, although its anterior outline is preserved in nearly all species whose interior characters are well marked. A median ridge may or may not be present in the interior of the dorsal valve.

The preservation of all vascular markings depends largely on the thickness of the shell, being rarely seen in thin shells and often found in thick ones.

There are six pairs of muscle scars that have been observed, in addition to the pedicle scar (m) which is situated on the ventral valve between the two scars (gg) left by the divided umbonal muscle close to the area; on the dorsal valve the single umbonal scar (g) is just in advance of the base of the area. The central scars (h) are usually situated about the center of the dorsal valve a short distance each side of a median septum; in the ventral valve they are inclosed in a trapezoidal area (c), with the scars of the outside and middle lateral muscles, on each anterolateral side of the heart-shaped area (x). The transmedian scars are shown as one scar on each side a little in advance of and on a line with the flexure lines of the area; the variation in their relative position in the two valves and in various species may best be understood by studying the illustrations and descriptions of species. The scars (k) of the middle lateral muscles are inclosed within the area (x) with the central and outside laterals; in the dorsal valve they blend with those of the outside laterals (l) in advance and a little outside of the transmedian scars (i). As previously stated, the scars of the outside lateral muscles in the ventral valve are combined with the central and middle laterals, while in the dorsal valve they are united with the middle lateral muscles. The scars of the anterior lateral muscles (j) of the ventral valve are usually so closely united with those of the transmedians (i) that it is only in unusually well-preserved specimens that the two scars can be differentiated; in the dorsal valve they are more or less in advance of the centrals, and divided by a narrow median septum or ridge; they may be situated a little back of the center of the valve or at any distance between that and a short distance from the frontal margin of the shell. In both valves the scar of the parietal band closely circumscribes all muscle scars externally, crossing the main vascular sinuses and terminating at the base of the flexure line of the area.

The principal forms of *Lingulella* may be grouped under five divisions by the outlines of the ventral valve.

Acuminate:
- *Lingulella perattenuata* (Pl. XXI).
- *L. acutangula* (Pl. XVII).
- *L. manticula* (Pl. XX).
- *L. nanno* (Pl. XXIV).

Subacuminate:
- *Lingulella davisi* (Pl. XXXI).

Ovate-elongate:
- *Lingulella bella* (Pl. XIX).

Ovate-quadrangular:
- *Lingulella mosia* (Pl. XVIII).
- *L. winona* (Pl. XVIII).

Subtriangular:
- *Lingulella auga* (Pl. XXIV).

Intermediate forms are illustrated by *Lingulella martinensis* (Pl. XXXVIII), which is rounded subtriangular and acuminate, and *L. phaon* (Pl. XXVI), which is both acuminate and subacuminate.

The outline, relative size, and position of the visceral areas (splanchnocœles) are exceedingly variable.

In *Lingulella oweni* (Pl. XVIII) the area is very short, while in *L. acutangula* (Pl. XVII), *L. perattenuata* and *L. similis* (Pl. XXI), *L. punctata* (Pl. XX), and *L. radula* (Pl. XLV) it is elongate. The narrow type of visceral area in the dorsal valve is seen in *Lingulella acutangula* (Pl. XVII), *L. hayesi* (Pl. XXV), *L. similis* (Pl. XXI), *L. manticula* (Pl. XX), *L. leos* (Pl. XXIV), *L. ampla* (Pl. XXVIII), and *L. radula* (Pl. XLV).

The surface characters vary from the almost smooth and highly polished *Lingulella nanno* (Pl. XXIV), on which only the faintest traces of radiating striæ and depressed rounded lines of growth are visible, to shells with strong concentric striæ and lines of growth, *Lingulella auga* (Pl. XXIV). Whenever the surface of the shell is sufficiently well preserved to permit close examination radiating striæ have been observed.

Observations.—Prior to the investigation of the material described and illustrated in this monograph,[a] the data relating to *Lingulella* were too meager to permit detailed comparison with

[a] Announced in a preliminary paper: Proc. U. S. Nat. Mus., vol. 21, 1898, p. 390.

other genera. The presence of a peculiar central channel in the cardinal area was the only character of importance observed by Davidson [1866, p. 55] that served to distinguish *Lingulella* from *Lingula*. In the original description, Salter [1866b, p. 333] calls attention to the resemblance of the muscular scars of *Lingulella* to those of *Obolus*, but he considers that the difference in relative position is sufficient to distinguish the two genera. Attention is also called [Salter, 1866b, p. 333] to *Obolella* Billings, and to the fact that the later figures of Billings "show a very different set of muscular scars." Davidson had the same material that Salter had and more, but was unable to find any satisfactory interiors, and hence left the genus as doubtful, evidently considering it as closely related to *Lingula*.

Mickwitz met with the same difficulty as Davidson, in having unsatisfactory material upon which to base an opinion. After stating [1896, p. 126] that *Obolella* Billings would probably have to make room for the genus *Obolus* Eichwald, he says: "Whether *Lingulella* Salter will share the same fate I will not venture to predict with the same degree of certainty, since the diagnosis and figures are even more imperfect than in Billings's genus."

When in Wales, in 1888, I made a small collection of *Lingulella davisi* (McCoy) at the type locality at Portmadoc, and later Mr. G. J. Williams sent me a number of fine specimens for study. With this material, supplemented by a beautiful series of specimens of a number of American species, it has been possible to obtain a clear conception of *Lingulella* and its relations to *Obolus*, *Obolella*, *Schmidtia*, *Lingulobolus*, *Lingulepis*, and *Lingula*.

The memoir of Mickwitz [1896] gave the genus *Obolus* a position that it had not held prior to his very thorough investigation. With his descriptions and plates and a fine suite of specimens worked out from material very generously given me by Dr. Fr. Schmidt, I have been able to make a series of comparisons with *Lingulella* that at times has led me almost to doubt the advisability of characterizing *Lingulella* as generically distinct from *Obolus*. This distinction is now based on the more elongate form of most of the species of *Lingulella*, and the greater thickness of the shell of the typical forms of *Obolus*. There are differences in the position, size, and form of the muscular scars, visceral area, and vascular canals of *Obolus* and *Lingulella*, but they are not greater than those between different species referred to *Lingulella*. The same general arrangement of muscle scars prevails, but on comparing the interior of the dorsal valve of *Lingulella davisi* (McCoy) (Pl. XXXI, fig. 6e) with that of *Lingulella acutangula* (Roemer) (Pl. XVII, fig. 1h) or *Lingulella ampla* (Owen) (Pl. XXVIII, fig. 1h) we find as great variation as when the comparison is made with the dorsal valve of *Obolus* (Pl. VII, figs. 6–9). The same is true of the ventral valve, although the means of comparison are in this case not so good. One of the oldest species of *Lingulella*, *L. granvillensis* Walcott (Pl. XXII) of the upper *Olenellus* zone, has the outline of *Obolus* (*Schmidtia*) *celatus* Volborth, and the interior markings of the ventral valve are also of the same type. *Lingulella acutangula* (Roemer) (Pl. XVII, fig. 1f) has the heart-shaped pit so characteristic of *Obolus* (Pl. VII, figs. 1–4) and the arrangement of the muscular scars is essentially as in *Obolus*, but the outline of the valve is much more elongate. *Lingulella davisi* (McCoy) and *Lingulella ampla* (Owen) vary decidedly from *Obolus* in the interior markings, but not more than *Lingulella ampla* differs from *Lingulella acutangula*. The variations are so well shown by the figures on the plates that detailed comparisons will not be entered upon.

Matthew [1899b, p. 201] proposed to distinguish *Obolus* from *Lingulella* by its—

> roundness of outline, short cardinal area and depressed beaks, advanced position of muscle scars in the valve, and strong arch of the vascular trunks in the ventral as well as the dorsal valve. There is, however, a more important distinction, which, in consequence of imperfect preservation of the valves, can seldom be observed; that is, the position of the secondary muscles of the central group in the ventral valve, as compared with the great muscle of that group. In *Obolus* they are lateral, but in *Lingulella* anterior to the great muscle. This shows a radical difference of structure between the two genera.

I am not able to recognize as constant the characters mentioned by Matthew, owing to the great variation in the large group of species referred to *Obolus* and *Lingulella*. The data for a clear distinction of the two, *Obolus* and *Lingulella*, are still too limited for more than an arbitrary reference of *Lingulella* to a generic place in relation to *Obolus*. This is particularly

the case with the position of the muscle scars of the ventral valve to which Matthew refers. The central muscles of the ventral valve of *Obolus* vary greatly in the position of the points of attachment; this is shown by Plate VII, figures 1–13, for *Obolus apollinis*. The scars of the central muscles of *Lingulella* are rarely preserved so that they can all be identified; in one species, *Lingulella acutangula* (Pl. XVII, figs. 1c and 1g), they appear to be arranged as in *Obolus apollinis*. The same is true for *Obolus* (*Westonia*) *escasoni* (Matthew) (Pl. XLIX, fig. 1aa).

The genus *Schmidtia* Volborth is made a subgenus of *Obolus* by Mickwitz [1896, p. 25]. A comparison of typical specimens of *Obolus* (*Schmidtia*) *celatus* Volborth and *Lingulella davisi* (McCoy) leads to the view that *Schmidtia* is identical with *Lingulella* except that *Lingulella* is a radially striated shell and *Schmidtia* is not. I did not fully appreciate this distinction when writing a preliminary notice [1898, p. 392] of the study of *Lingulella* and hence referred to *Schmidtia* as a synonym of *Lingulella*.

Any extended comparison with *Obolella* is unnecessary, as it is a thick, round-ovate shell with a cardinal area and pedicle opening unlike *Lingulella* or any of the subgenera of *Obolus*. *Lingulobolus* has the same arrangement of muscle scars as *Lingulella*, but differs in the greater thickness of the shell in both valves. *Lingulepis* is scarcely more than a very acuminate form of *Lingulella* with the area and visceral cavity of the ventral valve modified in shape to meet the extreme elongation of the posterior portion of the valve.

That *Lingulella* is closely related to *Lingula* is seen at once by comparing the markings on the interior of the two shells.

Under observations on *Obolus* (p. 375) the differences between *Obolus* and *Lingula* have been stated. *Lingulella* differs from *Lingula* in the same manner as *Obolus* in having its visceral area continued back to the posterior margin of the interior of the valves, but it has the same general form as *Lingula*. Without the interior of the valves for comparison it would be very difficult to determine that many of the Cambrian species were not true species of *Lingula*.

Matthew [1903, p. 105] refers a group of small shells heretofore placed under *Lingulella* to the Ordovician genus *Leptobolus* of Hall. He says:

> Such forms have usually been included in *Lingulella*, but in addition to their minute size they are separated from that genus by important characters.
>
> These little shells have thin test, weak umbones; vascular trunks are situated near the lateral margins, and both the central and lateral muscles in both valves are advanced far toward the front of the valves.

As a result of the examination of the types of the Ordovician species of *Leptobolus* I find that they have quite strong, thick shells in proportion to their size, quite as much so as the young shells of species of *Lingulella* that acquire thickened shells as they attain their full growth. The vascular trunks are well out toward the margin, but this feature also occurs in large forms of *Lingulella*, as indicated in the table under *Obolus* (p. 377). The position of the central and lateral muscle scars is also too variable a character to afford a basis for generic reference. *Leptobolus* is marked by a peculiar visceral area in the ventral valve unknown in any Cambrian shell, and the bifurcation of the strongly marked ridges of the path of advance of the central and lateral muscle scars in the dorsal valve is a distinguishing character not found in the Cambrian shells referred to *Leptobolus*. The Cambrian forms referred to *Leptobolus* by Matthew [1903] are: *L. atavus*, *L. atavus insulæ*, *L. atavus tritavus*, *L. collicia*, *L. collicia collis*, *L. flumenis*, *L. gemmulus*, *L.* cf. *linguloides*, and *L. torrentis*.

If the above species are included in a distinct genus, several others should go with them, notably: *Lingulella ferruginea* Salter (Pl. XXIX), *L. lepis* (Salter) (Pl. XXXI), and *L. cania* (Walcott) (Pl. XXXV).

One of the oldest species known of the genus *Lingulella*, *Lingulella schucherti* (Walcott) (Pl. XXI, fig. 6), is in all respects, so far as can be determined from the material, a true *Lingulella*. The shell is phosphatic, relatively thin, elongate, resembling in this respect *Lingulella acutangula* (Roemer) (Pl. XVII). From this it appears that we have in the *Olenellus* fauna of the Lower Cambrian, associated with *Obolella*, a typical representation of the genus *Lingulella*. This association shows that the differentiation in the group of brachiopods represented by *Lingula* and *Obolella*, or the Lingulidæ, had advanced a long way before the period in Lower

Cambrian time represented by the fauna at Troy, New York. It is to be borne in mind that the fauna at Troy was collected both from stratified and conglomerate limestones. On this account it is not practicable to state that all the species from either are from the same geologic horizon, but *Lingulella schucherti* (Walcott) (Pl. XXI) and *Obolella crassa* (Hall) (Pl. LIV) occur in the same pieces of limestone. *Lingulella granvillensis* Walcott (Pl. XXII) occurs at numerous places in Washington County, New York, in strata near the top of the Lower Cambrian zone. *Lingulella nathorsti* Linnarsson (Pl. XXXI, figs. 1, 1a–b) occurs in the *Holmia kjerulfi* zone of Sweden. It has nearly the outline of *Lingulella acutangula* (Roemer) in some examples of the ventral valve. (Compare Pl. XXXI, fig. 1c, with Pl. XVII, fig. 1a; and Pl. XXXI, fig. 1a, with Pl. XVII, figs. 1h–k; also fig. 1 on each of the two plates.) *Lingulella delgadoi* Walcott (Pl. XXIX, figs. 6 and 6a) from the *Olenellus* zone of Portugal is, from our present knowledge of it, a true *Lingulella*.

Matthew [1903, p. 109] in speaking of the growth of *Lingulella* and allied forms, speaks of a law that the young shells are often round and the adults more elongate. This is in accord with the view that the protegulum of all forms of the Atremata is semicircular or semielliptical. In *Lingulella* (*Lingulepis*) *gregwa* (Matthew) (Pl. XLIV) and *L.* (*L.*) *exigua* (Matthew) (Pl. XLIII) the young shells are more elongate than the adult, owing to the broadening of the anterior portions of the valves as they increase in size.

Lingulella? paliformis [Hall and Clarke, 1892c, Pl. II, figs. 6–8] has the form of some of the more acuminate species of *Lingulella*, but from a study of the type specimens I am led to conclude that the material is too limited to decide the true generic relations of the species. The area of the dorsal valve is like that of *Lingulella*, but the only specimen showing the area of the ventral valve suggests that the pedicle furrow was confined to the dorsal valve. Nothing is known of the interior markings of either valve.

The vertical range of *Lingulella* is from the upper horizon of the *Olenellus* or Lower Cambrian fauna to the summit of the Cambrian and into the Ordovician fauna. One of the oldest known species is *Lingulella schucherti* (Walcott), found in the limestone conglomerate at Troy, New York, in association with *Obolella crassa* (Hall), *Bicia gemma* (Billings), *Elliptocephala asaphoides* Emmons, etc. *Lingulella granvillensis* Walcott, which is associated with *Olenellus* in the strata referred to the upper portion of the *Olenellus* zone, *L. nathorsti* Linnarsson of the *Holmia kjerulfi* zone of Sweden, and *L. delgadoi* Walcott are found in association with *Olenellus*. The greatest development of the species is in the Middle and Upper Cambrian, only a few forms continuing on into the Lower Ordovician.

The small *Lingulella desiderata* ranges from the base of the Middle Cambrian in the Cordilleran region to the Ordovician. There may be specific differences, but in the large amount of material now available for study there are none that appear to be of specific importance. *Lingulella isse* also has a great vertical range.

Lingula attenuata Sowerby [Davidson, 1866, p. 44, Pl. III, figs. 18–27] has the form of *Lingulella* and may possibly be a survival into the Middle Ordovician of a species of the genus. We do not have sufficient data to know whether the interior markings of the valves are more like those of *Lingula* or *Lingulella*.

Of the 77 species and 4 varieties from the Cambrian referred to *Lingulella* in this monograph, 5 species occur in the Lower Cambrian, 46 species and 1 variety in the Middle Cambrian, 35 species and 3 varieties in the Upper Cambrian, 6 species in the passage beds between the Cambrian and the Ordovician, and there are 13 species from the Ordovician. Of the Middle Cambrian species 13 pass up into the Upper Cambrian, of which two are found in the Ordovician. Two species pass from the Upper Cambrian to the Ordovician and two from the Upper Cambrian to the passage beds.

The range of all known species is given in the tables of genera and species (pp. 98–113).

Subgenera of Lingulella.—Leptembolon Mickwitz [1896, p. 199] is rather difficult to characterize. Mickwitz [1896, p. 199] says of it:

> The subgenus *Leptembolon* is based on a species of *Obolus* which externally resembles *Lingula* very closely, and in fact was regarded as such by earlier authors [Schmidt, Fr., 1881, p. 17]. The specimens of the internal surfaces

of the valves, however, showed, together with some suggestions of the last-mentioned genus (*Lingula*), unmistakable marks of the genus *Obolus*, so that the species, which would not be assigned to any of the other groups, had to be ranked in a special subgenus of Eichwald's genus.

Type.—Obolus (*Leptembolon*) *lingulæformis* Mickwitz (Pl. XIV, figs. 5, 5a–b).

Lingulepis Hall [1863, p. 129] is a *Lingulella*-like shell with the ventral beak much attenuated. Type: *Lingula acuminata* Conrad.

For the species hitherto referred to *Lingulella* that are now referred to other genera or subgenera see pages 58–62.

Lingulella acutangula (Roemer).

Plate XVII, figures 1, 1a–o.

Lingula acutangula Roemer, 1849, Texas, p. 420. (Described in Latin and discussed in German as a new species.)

Lingula acutangula Roemer, 1852, Kreidebildungen von Texas, p. 90, Pl. XI, figs. 10a–b. (Described in Latin and discussed in German.)

Lingulepis acutangulus (Roemer), Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 259. (Merely changes generic reference.)

Obolus (*Lingulella*) *acutangulus* (Roemer), Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 392 and 394; Pl. XXVII, fig. 6; Pl. XXVIII, figs. 1 and 2. (Mentioned in the text in discussion of *Lingulella*. Figs. 6, 1, and 2 are reproduced in this monograph, Pl. XVII, figs. 1c, 1f, and 1h, respectively.)

General form elongate ovate with the ventral valve subacuminate and the dorsal valve ovate in outline. When the ventral valve is slightly compressed the cardinal slopes are often crushed down over the area about the pedicle groove, so as to make the outline of the valve more acuminate. This appears to be the case with the type figure of Roemer, and it is partly shown by Plate XVII, figure 1e. There is considerable range of variation in the outline of the valves (Pl. XVII). The convexity of the two valves is fairly strong, and it is nearly the same in each, except that the dorsal valve curves inward more rapidly toward the beak. A ventral valve 9 mm. in length has a convexity of 1.25 mm., and a dorsal valve 10 mm. long arches 1.5 mm. above the plane of the margin.

Surface of the shell marked by radiating and concentric striæ and lines of growth. The radiating striæ are usually indistinct, but in a number of shells they are well marked or interrupted somewhat by irregular rounded lines that alternate, blend, and disappear without any apparent system (Pl. XVII, fig. 1l). The concentric striæ are fine, usually having an unbroken curvature, but in some instances they are broken into short undulations, such as characterize the surface of several other species of *Lingulella*. In some examples the undulations are close and pronounced, and form a fine broken reticulation that is discernible only with a strong magnifying glass. When the outer layer of the shell is partly exfoliated the radiating striæ appear as sharp, clear-cut lines, but they do not extend to the inner surface of the shell (Pl. XVII, fig. 1l). The interior surface is usually marked by strong punctæ which vary greatly in number and arrangement. This is illustrated by the casts of the interior of several shells, where the punctæ are represented by papillæ. On figure 1c the papillæ are large and somewhat scattered, while in figure 1a they are smaller and arranged in concentric lines quite to the edge of the shell. In the dorsal valve the punctæ are not quite so strong and they do not extend out to the margin (Pl. XVII, figs. 1i, 1j, and 1k); in specimens showing the interior scars and markings the punctæ are less numerous (figs. 1f, 1h, and 1j).

The shell is thicker than in most species of the genus, in this respect resembling in a modified degree the type of *Obolus, O. apollinis* Eichwald. The shell is formed of a thin outer layer and several thinner layers or lamellæ that are slightly oblique to the outer layer (fig. 1m), a structure quite similar to that of the shell of the recent *Lingula anatina* Bruguière.

The longest ventral valve in the collection has a length of 14 mm., and a maximum width of 10 mm. Roemer's figure [1852, Pl. XI, fig. 10] is larger, 18 mm. by 13 mm. The average length of the ventral valve is from about 8 to 10 mm., and of the dorsal valve 6.5 to 8.5 mm. The relative dimensions of the two valves may be seen by a comparison of figures 1 and 1i, Plate XVII.

As determined by a study of interior casts, the plane of the cardinal area of the ventral valve coincides near its edges with the edge of the shell, rising slightly toward the deep, rounded pedicle furrow. The area is divided at the center by the pedicle furrow, and toward its margins by elevated lines, or extremely narrow ridges, that extend from the apex with a slightly outward curvature to the base of the area (the flexure marks of the area parallel with its base); they are rounded and strong in the pedicle groove, sharp and crowded on the lateral slopes; they cross the pedicle groove transversely, slope forward across the central spaces (splanchnocœle of Mickwitz [1896, p. 116]) curve almost backward in the flexure lines and slope forward at a low angle across the lateral spaces (pleurocœle of Mickwitz [1896, p. 116]). The area forms a thin shelf between the pedicle groove and the lateral margins, the undercut extending far back under the area. This is shown in the cast by a thin projection of the embedding rock over the area (Pl. XVII, figs 1a, 1c, and 1f), where the broken edges remain. The area of the dorsal valve is lower and less prominent; the striæ of growth cross it parallel to the anterior margin, being interrupted by the flexure lines, which are but slightly indicated on most specimens. The shallow furrow, corresponding to the pedicle furrow of the ventral valve, usually extends across the space between the flexure lines. The pedicle groove on the ventral valve is deep, narrow, and strongly defined, tapering very gradually from the anterior end toward the beak.

The cast of the visceral cavity (v), including the heart-shaped pit (x) of the ventral valve, is shown by Plate XVII, figures 1a, 1c, 1f, and 1g, the latter particularly well by figure 1f, where it strongly resembles the same space in *Obolus apollinis* Eichwald. There are no traces of a median septum in the ventral valve; in the dorsal valve it is shown in the casts as a very narrow, clearly defined, sharp depression (s) extending a short distance back of the central muscle scars, in some specimens, and forward nearly to the anterior lateral scars (Pl. XVII, figs. 1h and 1j).

The muscle scars are finely shown in casts of both valves. The umbonal scar (gg) of the ventral valve is divided as in *Obolus*, the pedicle scar (m) being situated between the two parts (Pl. XVII, fig. 1f); the latter are oval in outline, their longer axis being slightly inclined forward and outward. In the dorsal valve the umbonal scar (g) is very close to the area and extends across nearly the entire distance between the central portion of the area delimited by the flexure lines (Pl. XVII, figs. 1h and 1j). In one specimen fine striæ cross the scar subparallel to the median line of the shell.

The scars of the central muscles are not clearly defined in the ventral valve, owing to their being crowded in with the scars of the middle and outside laterals. Their position, judging from the location of the centrals in *Obolus*, is within the trapezoidal area (c) indicated on Plate XVII, figures 1f and 1g. The central muscle scars (hh) are large and distinctly defined on a number of casts of the interior of the dorsal valve. They are situated a little in advance of the center of the shell, on each side of the median septum, with their longer axis inclined outward at an angle of nearly 45° (Pl. XVII, figs. 1h and 1j). The anterior laterals (j) are clearly defined in both valves; their form, size, and position are shown by figures 1f and 1g for the ventral valve, and figures 1h and 1j for the dorsal valve. The middle and outside lateral scars on the ventral valve are situated in the trapezoidal area (c), but neither are clearly separable in any of the specimens in the collection unless it be in that represented by figure 1c, where a small round scar (k) occurs, corresponding in position to that of the middle lateral scars of *Obolus*. On the dorsal valve the middle and outside laterals are closely united as in *Obolus*, and they are apparently combined in the elongate scar (l) (Pl. XVII, figs. 1h and 1j). This scar corresponds in position with the two scars in *Obolus*, in which genus it is usually impossible to discover the line of demarcation between them. The transmedian scars (i) are distinctly shown on the dorsal valve (Pl. XVII, figs. 1h and 1j), but in the ventral valve they are so closely united with the anterior laterals (j) that it is impossible to differentiate them.

Portions of the markings left on the shell by the vascular system are finely preserved in a few casts of the interior of the valves. The description is of the present appearance of the casts, which is the reverse of the actual condition in the interior of the shell. The main or trunk

sinuses (vs) are indicated for the ventral valve in figure 1g, and for the dorsal valve by figures 1h and 1j. The latter are rather indistinct, rounded ridges, with a few lateral branches showing in the specimens. In figure 1g the interior lateral branches (ivs) are shown, and the peripheral sinuses (pvs) are seen in figures 1h and 1j, Plate XVII.

The parietal scar (ps) is distinctly shown in front of the visceral area of the ventral valve (Pl. XVII, fig. 1f), but it has not been traced outside of the main sinus. In one specimen of the dorsal valve its course may be followed from the median line in front of the anterior lateral muscle scars, curving outward to the main vascular sinus and outside of the sinus around the outside lateral, where it turns back toward the flexure line of the area (fig. 1j).

Observations.—The specimens described by Roemer [1849, p. 420] came from a limestone in San Saba County, Texas. He figures [1852, Pl. XI, fig. 10] a ventral valve that is larger and more acuminate than the majority of the specimens in the collection before me; but, in the absence of a closely allied species from the Cambrian of Texas, and in view of the fact that there is a considerable range of variation in the form of the valves, I do not hesitate to identify the form here described as belonging to the species studied by Roemer. He compares it [1852, p. 90] with "*Lingula cuneata*" of the Medina sandstone of New York, to point out that it is more acuminate than that species. It also differs from it in the character of the interior markings and muscle scars and the greater thickness of the shell. From other species of the genus, *Lingulella acutangula* varies in form and in the arrangement of the muscle scars. It is somewhat closely related to *Lingulella cuneola* (Whitfield) of the Middle Cambrian of the Black Hills, South Dakota, and the latter species may even be identical with it.

Formation and locality.—**Upper Cambrian:** (**14b**) Limestone on Cold Creek at north end of gorge opposite the north end of Sponge Mountain, 2 miles (3.2 km.) south of the San Saba County line, in Llano County; (**14i**) upper part of the limestone exposed 1 mile (1.6 km.) west of Cherokee, San Saba County; (**353**) *limestones [see Roemer, 1849, p. 420] on San Saba River, San Saba County;* (**68** and **68e**) interbedded limestone and sandstone, Packsaddle Mountain, Llano County; (**69**) limestone, near Honey Creek, Burnet County; (**67** and **67c**) sandstone on Tatur Hill, 7 miles (11.2 km.) northwest of Burnet, Burnet County; (**353c**) heavy dark ferruginous sandstone collected somewhere in Llano County; and (**70** and **70e**) limestone, near Morgans Creek, Burnet County; all in Texas.

Middle Cambrian: (**11j**) Basal part of Bonneterre limestone, Mine Lamotte, Madison County; and (**11k**) limestones of the "Edgewise beds," beneath the Elvins formation, St. Francois County; both in Missouri.

(**17c**) Sandy limestone, 235 feet (71.6 m.) above the "Tonto" sandstone, Grand View trail, north of Last Chance copper mine, south side of the Grand Canyon of the Colorado, Arizona.

Specimens that are somewhat doubtfully referred to *Lingulella acutangula* occur at the following localities:

Upper Cambrian: (**327**) Arenaceous limestone east of Gold Camp, in the Caballos Mountains, Sierra County, New Mexico.

(**11l**) Arenaceous limestone of the Elvins formation, 50 feet (15.2 m.) above the "Edgewise beds," St. Francois County, Missouri.

Middle? Cambrian: (**313c**) Limestone 12 miles (19.3 km.) west-southwest of Alpha Station, Eureka County, Nevada.

Lingulella agnostorum (Wallerius).

Plate XXX, figure 15.

Lingula agnostorum Wallerius, 1895, Undersökningar öfver Zonen med *Agnostus lævigatus* i Vestergötland, pp. 64–65, figs. 8a–b. (Described in Latin, and discussed in Swedish, as a new species.)

Shell very small. Outline ovate, with the ventral valve subacuminate; moderately convex. Surface of shell marked by concentric striæ and strong growth lines that, near the umbo, form deep undulations separating the minute, elevated, smaller umbo from the less elevated concentric ridges in front of it. The ventral valve illustrated by Wallerius is about 3 mm. in length and that of the specimen before me is 1.5 mm. I have not seen a dorsal valve.

Observations.—This minute shell is associated with *Acrotreta parvula* (Wallerius) and *Agnostus lævigatus*. It differs from *Lingulella* sp. undt. a of the *Olenus truncatus* zone in its minute size, more acute beak, and less distinctly striate surface characters.

This form owes its specific name to its association with *Agnostus*.

FORMATION AND LOCALITY.—(310i) Limestone in passage beds between the Middle Cambrian *Paradoxides forchhammeri* zone and the Upper Cambrian *Olenus truncatus* zone; at Borgholm, on Oeland Island, Sweden.

LINGULELLA AMPLA (Owen).

Plate XXVIII, figures 1, 1a–j.

Lingula ampla OWEN, 1852, Rept. Geol. Survey Wisconsin, Iowa, and Minnesota, p. 583, Pl. I B, figs. 5 and 12. (Described as a new species, see p. 478 for copy. The specimen represented by fig. 5 is redrawn in this monograph, Pl. XXVIII, fig. 1.)

Lingula ampla Owen, HALL, 1863, Sixteenth Rept. New York State Cab. Nat. Hist., p. 125, Pl. VI, fig. 10. (Original description, Owen, 1852, p. 583, copied and species discussed.)

Lingula ampla Owen, HALL, 1867, Trans. Albany Inst., vol. 5, pp. 101–102, Pl. I, fig. 10. (Discussion and figure copied from preceding reference.)

Lingulella ampla (Owen), SCHUCHERT, 1897, Bull. U. S. Geol. Survey No. 87, p. 257. (Merely changes generic reference.)

Obolus (*Lingulella*) *amplus* (Owen), WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 392 and 394, Pl. XXVIII, figs. 3–4. (Mentioned in the text in discussion of *Lingulella*. The specimens represented by figs. 3 and 4 are redrawn in this monograph, Pl. XXVIII, figs. 1f and 1h, respectively.)

General form ovate, with the ventral valve obtusely acuminate and dorsal valve broadly ovate; valves moderately convex. Surface of shell marked by concentric striæ, and lines of growth and indistinct radiating striæ; very fine radiating striæ occur on the inner surface of the outer layer of the shell, and the casts show the presence of papillæ that indicate that the inner surface of the shell was punctate (Pl. XXVIII, fig. 1g). The shell is of medium thickness and formed of a thin outer layer and several inner layers or lamellæ which give a greater thickness to the posterior half. The lamellæ are arranged as in *Lingulella acutangula* (Roemer) where they are slightly oblique to the outer layer.

One of the larger ventral valves has a length of 18 mm., with a maximum width of 12 mm., and an associated dorsal valve has a width of 12 mm. and a length of 15 mm.

As shown in the cast of the interior of the shell, the area of the ventral valve is nearly flat near its lateral margin and rises from about the flexure line toward the pedicle groove. The pedicle furrow is shown by a narrow, elevated, rounded, tapering ridge which divides the area midway. The area is marked also by rather strong flexure lines which extend from the beak obliquely across the area at some distance from the outer margin, as shown in Plate XXVIII, figures 1c–f. The striæ of growth cross the area parallel with its base; they are very fine and closely grouped together on the lateral slopes; none of the specimens show their presence on the cast of the pedicle furrow. The area forms a thin shelf between the pedicle groove and the lateral margins, the undercut extending backward far under the area. This is well shown in several of the casts, although the cast of the undercut is usually broken away. A portion of it remains, however, in Plate XXVIII, figure 1c.

The area of the dorsal valve is well defined and is marked in one specimen by strong flexure lines (f, fig. 1h), and fine transverse striæ. As in the ventral valve, the area forms a thin shelf, the cast of the undercut extending well under the area in several of the specimens. Its ragged edges are shown in figure 1i.

The cast of the interior of the ventral valve shows the visceral cavity (v), and there are slight traces of a median septum (s) in the dorsal valve (Pl. XXVIII, fig. 1h). The muscle scars are partly preserved. In the ventral valve the anterior laterals (j) are shown in one cast (Pl. XXVIII, fig. 1c). The central, middle lateral, and outside lateral muscle scars are all crowded together and lost in the space in front of the anterior portion of the visceral cavity. The central (h) and anterior lateral (j) muscle scars are well defined in the dorsal valve (Pl. XXVIII, figs. 1g and 1h).

Of the markings left on the cast by the vascular system only the main sinus (vs) is preserved (Pl. XXVIII, figs. 1c, 1d, and 1f for the ventral valve and figs. 1g and 1h for the dorsal valve).

Observations.—One of the specimens illustrated by Owen [1852, Pl. I B, fig. 5] is in this monograph represented by Plate XXVIII, figure 1. It appears to be a ventral valve that

has been broken away toward the apex. His second figure [1852, Pl. I B, fig. 12] is a partially covered dorsal valve which shows the characteristic form and the concentric striæ of the species. His description [1852, p. 583] is as follows:

> This species has a greater circumference and superficial area than any of the others hitherto discovered in F. 1. Shell nearly oval, rather flat; beak blunt, and not projecting beyond the general contour of the shell, and formed more after the manner of the beaks of Terabratulæ. A few faint concentric striæ. Length 11/16 of an inch; width 8/16 of an inch.
>
> This species occurs in the *Lingula* and *Obolus* grits, member c, near Mountain Island, at the Dalles of the St. Croix, and elsewhere in Wisconsin.

James Hall did not have the type before him when he described the species. He identified a form from the lower bed at Trempealeau, which he regarded [1863, p. 125] as the typical form of the species. The original type came from Mountain Island, in the Mississippi just above the mouth of Trempealeau River. It also occurs at about the same horizon 10 miles lower down on the west shore of the river, opposite the mouth of Black River. In general form, this species somewhat resembles *Lingulella billingsiana* (Whiteaves) from Newfoundland, but it differs from that species in the character of the surface markings and that of the interior markings and scars, especially those of the dorsal valve. The position of the main vascular sinus of the dorsal valve distinguishes it from other species of which we have the interior markings. In a specimen of the ventral valve (Pl. XXVIII, fig. 1f) there appears to be a unique marking (y) in the central anterior portion of the valve. It recalls the heart-shaped pit (x) of *Obolus* and *Lingulella acutangula* (Roemer) (Pl. XVII, fig. 1f), but it is so far away from the normal position of that pit that it appears to be the result of a malformation or an impression in the cast which accidentally resembles the outline of the heart-shaped pit.

FORMATION AND LOCALITY.—**Upper Cambrian**: "St. Croix sandstone" at the following localities: (**80**) 0.66 mile (1.1 km.) southwest of the railway depot at Menomonie, Dunn County; (**100**) near Menomonie, Dunn County; and (**98**) near Eau Claire, Eau Claire County; all in Wisconsin.

Middle Cambrian: (**84** and **84f**) "St. Croix sandstone," at Dresbach opposite the mouth of Black River, Winona County; (**84s**) near Dakota, Winona County; and (**339e**) *on Mountain Island, Minnesota, in Mississippi River just above the mouth of Trempealeau River;* all in Minnesota.

(**328g**) Wisconsin shore of the Mississippi, near Trempealeau, Trempealeau County; and (**328e**) "St. Croix sandstone" at St. Croix Falls, Polk County; both in Wisconsin.

A closely related if not identical species occurs at the following locality. A ventral valve from this locality is illustrated in Plate XXVIII, figure 1j.

Middle Cambrian: (**88a**) Limestone about 100 feet (30.5 m.) above the quartzitic sandstone at the base of the Cambrian in the northern suburbs of Deadwood, Black Hills, South Dakota.

LINGULELLA ARGUTA (Walcott).

Plate XXIV, figures 5, 5a–b.

Lingula? manticula WHITE (in part), 1874, U. S. Geog. Surveys W. 100th Mer., Prelim. Rept. on Invertebrate Fossils, pp. 9–10. (Described as a new species, including specimens referred to both *Lingulella arguta* and *L. manticula*.)

Lingula? manticula WHITE (in part), 1877, U. S. Geog. Surveys W. 100th Mer., vol. 4, pp. 52–53, Pl. III, fig. 2a (not fig. 2b). (Described and discussed. The specimen represented by fig. 2a is redrawn in this monograph, Pl. XXIV, fig. 5. The specimen represented by fig. 2b is referred in this monograph to *Lingulella manticula*.)

Obolus (*Lingulella*) *argutus* WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 396. (Described and discussed as below as a new species.)

General form ovate, with the ventral valve obtusely acuminate; valves moderately convex. Exterior surface of the shell unknown. Very fine radiating striæ and concentric lines of growth occur on the outer surface of the inner layer of the shell. The shell appears to be of medium thickness and formed of a thin outer layer and one or more thin inner layers or lamellæ. The type specimen of the ventral valve has a length of 6 mm. and a width of 4.5 mm.

Observations.—This species is founded upon one of the specimens illustrated by White [1875, Pl. III, fig. 2a] as *Lingula? manticula*. The broadly ovate form of the ventral valve clearly distinguishes it from that species. From the associated fragments of trilobites it evidently occurs at a lower horizon in the Middle Cambrian. A dorsal valve from the same locality

and in a slightly different character of limestone is illustrated and provisionally referred to the same species (Pl. XXIV, fig. 5a).

In outline this shell resembles *Lingulella bella* (Walcott) and *L. bellula* (Walcott) from Newfoundland; it is more broadly acuminate than these species and much smaller than *Lingulella bella*. It may also be compared with *L. punctata* (Walcott), from which it differs in being more ovate.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**313f**) *Limestone at Schellbourne, Schell Creek Range, White Pine County, Nevada.*

Middle Cambrian: (**3e**) Thin-bedded limestone less than 400 feet (121.9 m.) above the quartzitic sandstones of the Cambrian, near Ophir, Oquirrh Range, Tooele County, Utah.

(**11w**) About 1,050 feet (320 m.) above the Lower Cambrian and 3,350 feet (1,021.1 m.) below the Upper Cambrian in the shales forming 1d of the Swasey formation [Walcott, 1908f, p. 182], at the head of Dome Canyon; (**3w**) about 2,350 feet (716.3 m.) above the Lower Cambrian, and 2,050 feet (624.8 m.) below the Upper Cambrian, in the central portion of the thin-bedded limestones forming 1c of the Marjum limestone [Walcott, 1908f, p. 180], in the cliff about 2 miles (3.2 km.) southeast of Marjum Pass; (**10y**) about 2,900 feet (884 m.) above the Lower Cambrian and 1,500 feet (457.2 m.) below the Upper Cambrian in the central portion of the limestone forming 1a of the Marjum limestone [Walcott, 1908f, p. 179], about 1 mile (1.6 km.) south-southwest of Marjum Pass; (**3x** and **11x**) about 2,200 feet (670.6 m.) above the Lower Cambrian and 2,200 feet (670.6 m.) below the Upper Cambrian, in the limestones forming 1d of the Marjum limestone [Walcott, 1908f, p. 180], 2.5 miles (4 km.) east of Antelope Springs, in ridge east of Wheeler Amphitheater; and (**11q** and **11y**) about 2,350 feet (716.3 m.) above the Lower Cambrian and 2,050 feet (624.8 m.) below the Upper Cambrian, in the limestones forming 1c of the Marjum limestone [Walcott, 1908f, p. 180], 2.5 miles (4 km.) east of Antelope Springs, in ridge east of Wheeler Amphitheater; all in the House Range [Walcott, 1908f, Pls. XIII and XV], Millard County, Utah.

(**14m**) Limestone about 7 miles (11.2 km.) south of Towner's ranch, Indian Creek, Lincoln County; (**54**) Eldorado limestone [Walcott, 1908f, p. 184], on the east slope of Prospect Mountain, in New York Canyon, Eureka district [Hague, 1892, Atlas], Eureka County; (**59**) limestone at the base of the western slope of Combs Peak, near the plain of Antelope Valley, Eureka district [Hague, 1892, Atlas], Eureka County; and (**313e**) limestone 2 miles (3.2 km.) west of Green's ranch, White Pine County; all in Nevada.

A shell which is provisionally referred to *Lingulella arguta* occurs associated with the latter species in the following locality:

Middle Cambrian: (**313a**) Limestone at Schellbourne, Schell Creek Range, White Pine County, Nevada.

LINGULELLA ATAVA (Matthew).

Plate XXXV, figures 5, 5a–h.

Leptobolus atavus MATTHEW, 1899, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 3, No. 18, pp. 200–201, Pl. II, figs. 1a–b and d–f. (Described and discussed as a new species. The specimens represented by figs. 1a and 1d are redrawn in this monograph, Pl. XXXV, figs. 5 and 5c, respectively.)

Obolus (*Lingulepis*) *gregwa* WALCOTT (in part) [not (MATTHEW)], 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 692 and 694. (Matthew's "*Leptobolus atavus*" mentioned as the young of "*Lingulepis gregwa*.")

Obolus (*Lingulella*) *atavus* (Matthew), WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 609–610. (Described and discussed essentially as below.)

Leptobolus atavus MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 106–109, Pl. VI, figs. 2a–b and d–g. (Described and discussed. Figs. 2a–b, d–e, and g are copied from Matthew, 1899b, Pl. II, figs. 1a–b and d–f, respectively.)

General form elliptical, with the ventral valve subacuminate, and the dorsal valve broadly subacuminate in outline. In the shorter form of the valves the sides are almost uniformly rounded from the cardinal slopes to the frontal margin. The convexity of the valves is fairly strong, that of the dorsal valve being broken by a slight longitudinal flattening that extends from the posterior portion to the frontal margin. As shown by the matrix, the outer surface is marked by concentric ridges and fine striæ of growth. The interior cast shows concentric lines and traces of rather coarse radiating lines. None of the specimens preserve the shell, but from the strength of the interior surface markings it is inferred that the shell was rather thick.

The longest ventral valve in the collection has a length of 6 mm.; width, 3.5 mm. The dorsal valves are slightly shorter.

The area of the ventral valve is divided at the center by a strong pedicle furrow, and about midway between the pedicle furrow and the outer margin by clearly marked flexure

lines that extend from the apex, with a slightly outward curvature, to the base of the area. Striæ of growth cross the area parallel with its base, being much stronger on the area than in the pedicle furrow. The area of the dorsal valve is fully as prominent as that of the ventral valve. It curves forward at the center and extends well out on the cardinal slopes. The flexure lines are clearly defined well out toward the lateral margin. The striæ of growth cross the area parallel to the base.

The cast of the interior of the ventral valve shows only the outline of the visceral cavity, and that the main vascular sinuses extend a considerable distance in advance of the visceral cavity. The cast of the interior of the dorsal valve shows that it had a strong, broad, central ridge, divided by a faint longitudinal median sinus. Only traces have been seen of the main vascular sinuses.

Observations.—This is a very pretty little species that, in the absence of well-defined specimens, I [1901, p. 694] confused with the young of *"Lingulepis gregwa"* Matthew. Material collected by S. Ward Loper at the type locality, however, proves that the shell differs considerably from that of the young of *Lingulella* (*Lingulepis*) *gregwa*, although specimens of the dorsal valve of the two forms are often very much alike.

Matthew's illustrations [1903, Pl. VI, figs. 2a–b, d–g] of *Lingulella atava* are somewhat diagrammatic, as though they were drawn to represent the average form of several specimens. With the type specimens before me I find considerable variation in width and outline. Some have the outline of *Lingulella collicia* (Matthew) and the two types of the latter species are much like Matthew's figures of *Lingulella atava* [1903, Pl. VI, figs. 2a–b, d–g]. The specimens of *Lingulella collicia* have the rotund, subquadrate outline of *Lingulella atava* and not the uniform curvature of Matthew's figures of *Lingulella collicia* [1903, Pl. VI, figs. 3a, 3b]. With a large series of well-preserved material from the type locality and formation, I have endeavored to represent two forms that may be referred to *Lingulella atava* and *Lingulella collicia*, respectively. *Lingulella atava* is more slender and its sides are more uniformly curved than *L. collicia*, and it is also usually larger. *Lingulella cania* (Walcott) is a narrow, elongate form.

Formation and locality.—**Middle Cambrian:** (**10p**) Sandstones just below the waterfall in Division E2b; (**13d** and **13d′**) sandstones opposite the third waterfall, between Divisions E2a and E2b; (**131′**) sandstones of Division E3a; (**344**) sandy shales of Division E3b; (**13n″** and **344b**) sandstones of Division E3d; (**13n′**)[a] *sandstones of Division E3e;* and (**13n** and **344d**) sandstones of Division E3f; all in Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia, Canada.

Lingulella atava insulæ (Matthew).

Plate XXXV, figures 8, 8a.

Leptobolus atavus insulæ Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 110–112, Pl. VI, figs. 4a–c. (Described and discussed as a new variety. The specimens represented by figs. 4a and 4b are redrawn in this monograph, Pl. XXXV, figs. 8 and 8a, respectively.)

The form of this shell is much like that of *Lingulella cania* (Walcott) or a narrow *L. atava* (Matthew). The material representing it is not well preserved. Matthew [1903, Pl. VI, figs. 4a–c] has illustrated it with three somewhat diagrammatic figures that give his conception of its form and interior markings. I have figured two of the best preserved of the typical specimens. They show the general form and character to be similar to those of *L. atava.*

Formation and locality.—**Middle Cambrian:** (**307d** [Matthew, 1903, p. 110]) Sandstones believed to belong to Division E2a of Matthew's Etcheminian, at Youngs (McFees) Point, George River, eastern Cape Breton, Nova Scotia.

Lingulella auga (Walcott).

Plate XXIV, figures 6, 6a–g.

Obolus (*Lingulella*) *auga* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 396–397. (Described as below as a new species.)

General form subcuneate, with ventral valve obtusely acuminate, and the dorsal valve rounded acuminate; valves moderately convex. Surface of the shell, as indicated by casts

[a] **13n′** is the type locality, though the specimens in the United States National Museum collections to which that number is assigned were collected later than the type specimens. Localities **344, 344b,** and **344d** are cited by Matthew (see pp. 268–269).

in the fine sandstone, marked by lines of growth, and fine, slightly undulating striæ; the inner surface is marked by somewhat irregularly scattered pits or punctæ, some of which are unusually large for the size of the shell. The few remaining traces of the shell indicate that it was relatively thin. The largest well-preserved cast of the ventral valve has a length of 5 mm., with a width of 4.5 mm. The dorsal valves are a little shorter, the length and breadth being nearly the same. Casts of the interior of the ventral valve show the presence of a rather long area divided midway by a narrow, clearly defined cast of a pedicle groove; traces of flexure lines are also preserved. The area of the dorsal valve is proportionately shorter than that of the ventral valve; traces of the visceral cavity (v) and the base of the main vascular sinuses (vs) are preserved in a few specimens and in one specimen the anterior lateral muscle scars appear to be present.

Observations.—In the form of the valves this species is somewhat similar to *Lingulella grandis* (Matthew) (Pl. XXXVIII); otherwise it appears to be quite distinct from any other described species. It has a long cardinal area and a narrow, deep pedicle furrow on the ventral valve.

Formation and locality.—**Middle Cambrian:** (10a) *Sandstones of the Rome formation, in west railroad cut through Shooks Gap;* and (10b) limestones of the Rome formation at the western end of the central railroad cut through Shooks Gap; both in Bays Mountains, 10 miles (16.1 km.) southeast of Knoxville [Keith, 1895, areal geology sheet], Knox County, Tennessee.

Lingulella bella (Walcott).

Plate XIX, figures 2, 2a–q; Plate XXXVI, figure 4.

Obolus (*Lingulella*) *bellus* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 397–398. (Described and discussed as a new species.)

Obolus (*Lingulella*) *bellus* Walcott (in part), 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 685–687. (Described and discussed, including specimens now referred to *Lingulella concinna* Matthew and *L. lens* (Matthew).)

Obolus (*Lingulella*) *bellus* Walcott, Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 204. (Says "*O.* (*L.*) *bellus*" does not include "*Lingulella concinna*".)

General form ovate, with ventral valve obtusely acuminate, and dorsal valve broad ovate to ovate quadrate; valves moderately convex as far as can be determined from the somewhat compressed specimens as they occur in the sandy shales. The small ventral valves are more acuminate than the large ones and the smaller dorsal valves are more elongate. The change in form is slight from one to another specimen in the series, but the two extremes are so different that without the connecting series two species could be determined.

Surface of shell with numerous concentric lines of growth and fine radiating lines. The inner layers are marked by concentric lines and numerous fine radiating striæ.

The shell is relatively thin over the anterior portions and stronger near the cardinal margins. It is formed of a very thin outer layer, with one or more thin layers or lamellæ. The casts of the interior surface of the ventral valve show numerous papillæ arranged in concentric lines on the posterior half of the shell. These correspond to the punctæ of the inner surface.

A large ventral valve has a length of 22 mm.; width, 15 mm.; and a dorsal valve 18 mm. in length had a width of 14 mm. The specimens in the collection average from 2 to 3 mm. smaller than those measured.

The cast of the area of the ventral valve shows that it was rather long and extended well out onto the cardinal slope; it is divided midway by a strong pedicle furrow, and toward the lateral margin by a narrow flexure line. The area is marked by fine striæ of growth parallel to the margin. The area of the dorsal valve is rather short, but it extends laterally well out on the cardinal slopes. The shallow curve corresponding to the pedicle groove of the larger valve is wide and clearly defined.

The casts of the interior of the valves show almost no traces of the vascular markings or muscle scars. Only the central and anterior lateral muscle scars and the main vascular sinuses have been observed in the ventral valve.

Observations.—This fine species occurs in great abundance in the upper beds of Little Belle Island associated with a narrow form of *Lingula;* and also in the higher beds on Great Belle Island, and a little below the layers carrying *Obolus* (*Lingulobolus*) *affinis* (Billings) and *O.* (*L.*) *spissus* (Billings). The species is found at some little distance above the horizon in which I collected a species of *Olenus* and I refer the horizon to the Ordovician or the passage beds to the Ordovician fauna.

The species appears to be clearly distinct from any described form. It may be compared with *Lingulella davisi* (McCoy) in relation to its size and outline, but not in other respects. It differs in the size and position of the muscle scars and the more strongly punctate interior surface. Some of the smaller shells closely resemble *Lingulella concinna* Matthew and the larger ones *L. lens* (Matthew). When studying the material of the two latter forms in 1901, I referred them all to *Lingulella bella* [Walcott, 1901, p. 685], but with the large series now before me this reference is not sustained.

Formation and locality.—**Lower Ordovician: (114b)** *Sandstone 1 mile (1.6 km.) north of Lance Cove, Great Belle Island, Conception Bay, Newfoundland.*

Upper Cambrian: (**114** and **114a**) Uppermost sandstone beds and the sandy shales underlying them on Little Belle Island, in Conception Bay, Newfoundland.

(**343b**) Limestone pebble on Sachuset Beach, near Newport, Narragansett Bay, Rhode Island.

Lingulella bellula (Walcott).

Plate XIX, figures 1, 1a–e.

Obolus (*Lingulella*) *bellulus* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 398. (Described and discussed as below, as a new species.)

Obolus (*Lingulella*) *bellulus* Walcott, Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 205. (Says this species and "*Lingula billingsana*" Whiteaves are the same.)

General form ovate with the ventral valve obtusely acuminate; dorsal valve round ovate; valves moderately convex. Surface of shell marked by concentric lines of growth and exceedingly fine, irregular striæ that give the same appearance to the surface as that seen on *Obolus* (*Westonia*) *ella* (Hall and Whitfield), *Obolus fragilis* (Walcott), and on a larger scale on *Lingulella radula* Matthew. The outer layer of the shell usually adheres to the arenaceous matrix, leaving the shiny inner layer on the shell; this is marked by concentric striæ and lines of growth, and fine radiating striæ. The shell is thin and formed of a very thin outer layer and one or more thin inner layers or lamellæ.

The average length of the ventral valve is from 4 to 5 mm.; width, 3 to 3.5 mm. The dorsal valves are a little shorter, 0.5 mm. to 1 mm.

The cast of the area of the ventral valve shows it to be elongate, divided midway by a narrow but strong pedicle furrow, and, about midway between the pedicle furrow and the lateral margin, by a narrow flexure line; it is marked by striæ of growth parallel to its base. The area of the dorsal valve is not well shown on the specimens in the collection.

The cast of the interior of the ventral valve shows somewhat imperfectly the visceral cavity, but not the muscle scars. In an interior of the dorsal valve the main vascular sinuses (vs) are well shown (Pl. XIX, fig. 1d), also the median septum (s). The central muscle scars are faintly shown in one fragmentary interior of the dorsal valve.

Observations.—This beautiful little species occurs in the arenaceous shales and thin-bedded sandstones of Little Belle Island, in association with the larger species *Lingulella bella* (Walcott). It is closely related to *Lingulella ferruginea* Salter, but differs somewhat in form and the more anterior position of "the visceral cavity in the dorsal valve." The species is the Upper Cambrian representative of the Middle Cambrian species *L. ferruginea.* It occurs at about the same horizon as *L. billingsiana* (Whiteaves), but differs decidedly from it in form and convexity, the only points of comparison which the material permits.

Formation and locality.—**Upper Cambrian:** (**114** and **114a**)[a] Uppermost sandstone beds and the sandy shales underlying them on Little Belle Island, Conception Bay, Newfoundland.

[a] **114a** is the type locality.

Lingulella billingsiana (Whiteaves).

Plate XXIX, figures 3, 3a.

Lingula billingsiana Whiteaves, 1878, Am. Jour. Sci., 3d ser., vol. 16, p. 226. (Described, see below, as a new species.)
Lingulella? billingsana (Whiteaves), Schuchert (in part), 1897, Bull. U. S. Geol. Survey No. 87, p. 256. (Merely changes generic reference and spelling of Whiteaves's *Lingula billingsiana*, cited above. Includes also reference to specimens now referred to *Lingulella grandis*.)
Not *Lingula billingsana* Whiteaves, Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 205. (Mentions "*Obolus* (*Lingulella*) *bellulus*" Walcott as the same as "*Lingula billingsana*.")

The original description by Whiteaves follows:

Shell small, very slightly convex, compressed at the sides; outline elliptic ovate, narrowest behind; length nearly twice the width; margin of the valves widening convexly and gradually from the beaks to the center, or a little beyond it; front narrowly and evenly rounded. Surface marked by fine concentric striations and faint radiating lines. Internal markings unknown. Length, about two lines and a half; width, one line and a half.

Observations.—Through the courtesy of Prof. J. F. Whiteaves I have been able to study the type specimens of this species. Much to my surprise I find them to be distinct from the forms (*Lingulella bella* and *L. bellula*, Pl. XIX) I collected on Little Belle Island and Great Belle Island, Conception Bay, and those (*Lingulella grandis* (Matthew), Pl. XXXVIII) tentatively compared with the species by Matthew. The shell is more elongate and convex than that of *Lingulella bella* (Walcott). Two specimens of the ventral valve are illustrated (Pl. XXIX, figs. 3 and 3a). No dorsal valves occur in the material available for study.

The outer surface is exfoliated from all of the specimens so as to show the shiny surface of the inner layer described by Whiteaves [1878, p. 226]. One of the broken ventral valves shows a narrow pedicle groove.

The specific name was given in honor of Mr. E. Billings.

Formation and locality.—**Upper Cambrian**: (314a [Whiteaves, 1878, p. 226]) Shales on Kelleys Island, Conception Bay, Newfoundland.

Lingulella bornemanni (Walcott).

Plate XXX, figures 18, 18a–c.

Lingula attenuata Bornemann [not Sowerby], 1891, Nova Acta Acad. Cæs. Leop.-Carol. Germanicæ Naturæ Curiosorum, Bd. 56, No. 3, pp. 437–438, Pl. XIX (XXXIV), figs. 1–10. (Described and discussed in German, see below for liberal translation. Figs. 10a, 4, 8, and 7 are reproduced in this monograph, Pl. XXX, figs. 18, 18a–c, respectively.)
Obolus (*Lingulella*) *bornemanni* Walcott, 1901, Proc. U. S. Nat. Mus., vol. 22, pp. 687–688. (Described and discussed essentially as below as a new species.)

The original description by Bornemann follows:

Shell oblong oval, sharply pointed toward the beak, marked with fine concentric stripes which are usually regular, and also often marked with large, irregular, concentric folds. Faint radial or longitudinal striation usually appears distinctly on the surface in the center of the shell. At the vertex there is usually a distinct, straight, longitudinal impression.

Shape exceedingly variable, often unsymmetric, short rounded-triangular or almost circular, or narrower and elongated, more or less arched or even flat. The long-extended specimens resemble *Lingulella* (*Lingulepis*) *acuminata* (Conrad); others agree perfectly with Murchison's original figures of *Lingula attenuata;* others again may be compared with *Lingulella davisi* (McCoy) and were at first placed with that species. The simultaneous occurrence in enormous multitudes and the numerous transition stages leave no doubt that all these forms belong to one species, and the average type of them fits best to *Lingula attenuata* Sowerby.

Size, 2 to 9 mm.

The state of preservation is best in the slates, yet there the specimens are mostly pressed flat. The specimens existing in great numbers in the sandstones often still exhibit their original arching, but the delicate shells are ordinarily distorted in an irregular manner and poorly preserved.

Bornemann [1891, p. 437] identified this species with *Lingula attenuata* Sowerby, on account of the resemblance in outline of many of the specimens. Other specimens closely resemble *Lingulella* (*Lingulepis*) *acuminata* (Conrad) from the Middle and Upper Cambrian of North America. It is so improbable that a species of this character should persist from Middle Cambrian time to Middle Ordovician time that, notwithstanding the resemblance, I think it is better to

distinguish it from *Lingula attenuata* Sowerby [Davidson, 1866, p. 44] and give a specific name that will not lead to erroneous stratigraphic correlations. The Cambrian fauna of Sardinia is so distinct from that of other localities and the stratigraphic succession of the subfauna is so confused that I think it unwise to identify its species with described species unless the material is so full and well preserved that there is no doubt of their specific identity.

The specific name was given in honor of Dr. J. G. Bornemann.

FORMATION AND LOCALITY.—**Middle? Cambrian**: (**354**) *Yellowish-brown slates not far from the buildings of Canal Grande;* (**354a**) grayish-white quartzitic sandstone in the valley of Gutturu Sartu; (**354b**) yellowish sandstone with *Archæocyathus* at Punta Pintau and elsewhere; all [Bornemann, 1891, p. 438] in the island of Sardinia, Italy.

LINGULELLA BUTTSI Walcott.

Plate XXIX, figures 4, 4a–b.

Lingulella buttsi WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 70–71, Pl. VIII, fig. 6. (Described and discussed as below as a new species. Fig. 6 is copied in this monograph, Pl. XXIX, fig. 4.)

General form elongate ovate, with the ventral valve bluntly acuminate and the dorsal valve a little more rounded on the posterior margin. Both valves rather strongly convex. The greatest convexity of the dorsal valve is at the umbo, and of the ventral valve along the central section. A ventral valve 12 mm. in length has a convexity of 2 mm., and a dorsal valve 8 mm. long arches 1.75 mm. above the plane of the margin. A narrow, median, slightly flattened, almost concave space that extends from the apex to the front margin occurs on the dorsal valve. The exterior surface of the shell is dull dark-bluish gray and the inner layers shiny bluish black. The outer surface is marked by concentric striæ and lines of growth with a few indistinct radiating striæ; the striæ on the dorsal valve bend slightly backward where they cross the median, flattened space. The inner layers have many concentric striæ, also numerous fine radiating striæ. The shell is built up of several layers or lamellæ, so as to be strong in the umbonal region and thin toward the edges.

The largest ventral valve in the collection has a length of 12 mm. and a maximum width of 9.5 mm. at the anterior third of its length; a dorsal valve 10 mm. long has a width of 7 mm.

A partly exfoliated ventral valve indicates the presence of a strong ridge on each side of the visceral area somewhat similar to that in *Lingulella acutangula* (Roemer) (Pl. XVII).

Observations.—This fine shell has the general outline of the group of small shells of which *Lingulella ferruginea* Salter is typical. It differs from them in its large size and strong shell. All of the larger species of *Lingulella* are either more acuminate or broader in outline.

The material was collected by Mr. Charles Butts, of the United States Geological Survey, and I take pleasure in naming the species after him.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**90b**) Conasauga limestone in cut on Louisville and Nashville Railroad, near Woodstock; and (**90c**) *Conasauga limestone near Kimbrel;* both in Bibb County, Alabama.

LINGULELLA CANIA (Walcott).

Plate XXXV, figures 3, 3a–d.

Obolus (*Lingulepis*) *gregwa* WALCOTT (in part) [not (MATTHEW)], 1901, Proc. U. S. Nat. Mus., vol. 23, p. 694. (Specimens now referred to *Lingulella cania* are here mentioned as representing the young of *Lingulella* (*Lingulepis*) *gregwa.*)

Obolus (*Lingulella*) *canius* WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 610–611. (Described as below as a new species.)

Shell small. General form elongate oval, with the ventral valve slightly acuminate. In both the ventral and dorsal valve the shell narrows posteriorly, the front being broadly rounded. The convexity of the two valves is well marked, and it is nearly the same in each.

Surface of the shell marked by fine concentric striæ and a few lines of growth. When the outer shell is exfoliated fine radiating striæ cross the fine concentric striæ. The shell appears to be of moderate thickness and formed of several thin layers or lamellæ. The largest ventral valve in the collection has a length of 5 mm.; width, 3 mm.; and a dorsal valve 4 mm. in length has a width of 2 mm.

The area of the ventral valve is elongate, being nearly one-fifth the length of the shell. It is divided midway by a very distinctly defined pedicle furrow. The flexure line is just perceptible about half the distance out from the pedicle furrow to the lateral margin.

The area extends well forward on the cardinal slopes and is marked by strong striæ of growth parallel to its base. The area of the dorsal valve is shorter than that of the ventral, and is marked by fine lines of growth and clearly marked flexure lines that extend from the apex forward on a line with the main vascular sinuses.

The cast of the interior of the ventral valves shows a general outline of the visceral cavity and the main vascular sinuses. Only the base of the main vascular sinus has been seen in the dorsal valve.

Observations.—This very pretty little species occurs in association with *Paradoxides*. In my first study of the brachiopods collected by S. Ward Loper from Cape Breton I confused it [1901, p. 694] with the young of *Lingulella* (*Lingulepis*) *gregwa* (Matthew). By means of a larger collection made by Loper in 1901, I have been able to separate it from the young of the associated *Lingulella* (*Lingulepis*) *exigua* (Matthew) and from somewhat similar species that occur at a lower horizon, *Lingulella atava* (Matthew) and *L. collicia* (Matthew). It differs from both the latter species in having a more elongate oval outline. It differs from the young of *Lingulella* (*Lingulepis*) *gregwa* in being more regularly oval and in having the posterolateral margin curved instead of nearly straight.

Formation and locality.—**Middle Cambrian**: (**3i**) *Compact, fine-grained, thin-bedded, gray sandstone of the Paradoxides zone, on McLeans Brook, 1 mile (1.6 km.) east of McCodrum Brook and 1.5 miles (2.4 km.) west of Marion Bridge;* and (**10s**) sandstone on McLeans Brook, near Marion Bridge; both in eastern Cape Bretou, Nova Scotia, Canada.

Lingulella cedens (Barrande)

Plate XXX, figure 8.

Lingula cedens Barrande, 1868, Faune silurienne des environs de Hof, en Bavière, p. 102, fig. 66. (Described in French. Fig. 66 is copied in this monograph, Pl. XXX, fig. 8.)

Lingula cedens Barrande, 1868, Neues Jahrb. für Mineralogie for 1868, pp. 691–692, unnumbered plate, fig. 66. (Copy of preceding reference.)

This is one of the larger shells of the fauna at Hof, but as it is deformed by pressure it is difficult to give its specific characters. The author states that the surface of the internal cast contains traces of rather strong concentric striæ, with finer intermediate striæ; also traces of very fine longitudinal striæ. Length, 18 mm.; greatest width, 12 mm.

Barrande [1868a, p. 102] compares this form with *Lingulella davisi* (McCoy), from which it appears to be very little different. It is probable that an extended series of specimens would unite it with *Lingulella wirthi* (Barrande).

Formation and locality.—**Passage beds** between the Upper Cambrian and the Ordovician: (**303c** [*Barrande, 1868a, p. 102*]) *Suburbs of Hof;* and (**303f** [Pompeckj, 1896a, pp. 7 and 8]) railway cut near Schellenberg, a little distance back of the railway station at Neuhof, near Hof; both in Bavaria, Germany.

Lingulella clarkei n. sp.

Text figures 42A–D, page 486.

The ventral valve of this species has the same general outline and form as that of *Lingulella acutangula* (Roemer) (Pl. XVII, figs. 1, 1a, 1g) except that it is a little broader across the front. The dorsal valve differs materially in being proportionally narrower on the posterior half and in having a broad shallow sinus extending from the umbo to the front margin. A similar sinus occurs on one dorsal valve of *Lingulella manticula* (White) (Pl. XX, fig. 1a) and on all dorsal valves of *Obolus* (*Fordinia*) *perfectus* Walcott (Pl. LXIII, fig. 10b).

The largest ventral valve has a length of 9 mm.; width, 7 mm. A broad dorsal valve has a length of 5 mm.; width, 4.25 mm.

The exterior surface is marked by very fine concentric striæ or fine ridges of growth; numerous radiating striæ occur on the inner layers of the shell. Nothing is known of the interior of either valve.

The specific name is given in honor of Prof. J. M. Clarke, of Albany, New York.

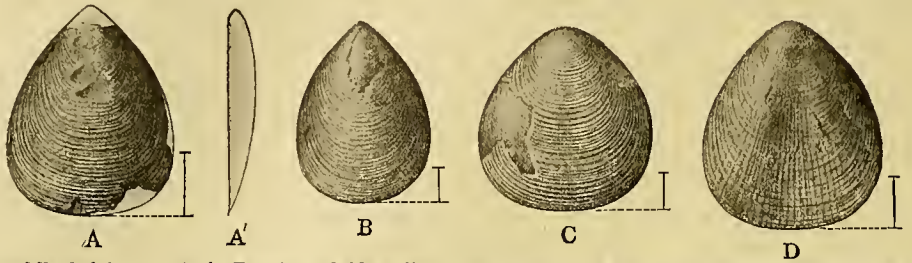

FIGURE 42.—*Lingulella clarkei* n. sp. A, A′, Exterior and side outline of ventral valve (U. S. Nat. Mus. Cat. No. 51853a). B, Exterior of ventral valve, the type specimen (U. S. Nat. Mus. Cat. No. 51853b). C, Broad form of dorsal valve (U. S. Nat. Mus. Cat. No. 51853c). D, Dorsal valve with exterior layer of shell exfoliated (U. S. Nat. Mus. Cat. No. 52458a).

The specimens represented by figures 42A, 42B, and 42C are from Locality **58**; that represented by figure 42D is from Locality **60**; both in Nevada.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**60**) Limestone in the upper beds of the Secret Canyon shale, across the canyon from the dump of the old Richmond mine shaft; and (**58**) *shaly limestones in the upper part of the Secret Canyon shale, east side of New York and Secret canyons;* both in the Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

LINGULELLA COLLICIA (Matthew).

Plate XXXV, figures 1, 1a–f, 2, 2a–d.

Leptobolus? collicia MATTHEW, 1899, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 3, No. 18, p. 200, Pl. I, figs. 3a–e. (Described as a new species. Figs. 1, 1a–b, Pl. XXXV, of this monograph are drawn from three of Matthew's specimens, but closer identification is impossible.)

Obolus (*Lingulella*) *collicia* (Matthew), WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 610. (Characterized.)

Leptobolus collicia MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 112–113, Pl. VI, figs. 3a–e. (Described and discussed. Figures copied from Matthew, 1899b, Pl. I, figs. 3a–e.)

Leptobolus collicia collis MATTHEW, 1903, idem, pp. 114–115. (Characterized as a new variety.)

This shell is associated with *Lingulella atava* (Matthew), but differs from that species in being larger and in having a more acuminate and broader ventral valve and more broadly oval dorsal valve. The exterior surface is marked by very fine, slightly irregular, concentric striæ. The variety *collis* is simply a wide form, that is so closely united to *L. collicia* by many gradations among the shells before me that I do not think it worthy of a distinct name.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**10p**) Sandstones just below the waterfall in Division E2b; (**13d′**) sandstones opposite the third waterfall in Dugald Brook, between Divisions E2a and E2b; (**344a** [Matthew, 1903, p. 26]) sandy shales of Division E3c; (**13n′**)[a] *sandstones of Division E3e;* (**344d** [Matthew, 1903, p. 82]) sandy shales of Division E3f; all in Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, Cape Breton, Nova Scotia.

(**13m**) Sandstones of Division E3f in Matthew's Etcheminian, Gillis Brook, eastern Cape Breton, Nova Scotia.

(**344e** [Matthew, 1903, p. 78]) Shales of Division E1d of Matthew's Etcheminian, on Boundary Brook, eastern side of the Escasonie Indian Reservation, eastern Cape Breton, Nova Scotia, Canada.

LINGULELLA CONCINNA Matthew.

Plate XXXIII, figures 2, 2a–h; Plate XXXIV, figures 1, 1a–r.

Lingulella concinna MATTHEW, 1901, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 4, No. 19, pp. 273–274, Pl. V, figs. 2a–b. (Described and discussed as a new species. Pl. XXXIII, fig. 2d, of this monograph is drawn from one of Matthew's specimens, but which one can not be determined.)

Obolus (*Lingulella*) *bellus* WALCOTT (in part), 1901, Proc. U. S. Nat. Mus., vol. 23, p. 685. (Matthew's *Lingulella concinna* is referred to, and described with *Lingulella bella*.)

Obolus (*Lingulella*) *concinnus* (Matthew), WALCOTT, 1902, idem, vol. 25, pp. 608–609. (Described and discussed somewhat as on p. 487.)

[a] 13n′ is the type locality, though the specimens in the United States National Museum collections to which that number is assigned were collected later than the type specimens.

Lingulella concinna MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 203–204, Pl. XIV, figs. 5a–b. (Description and figures copied from Matthew, 1901a, p. 273, Pl. V, figs. 2a–b.)

General form ovate. Ventral valve obtusely acuminate; dorsal valve broad, rounded ovate; valves moderately convex. Surface of shell marked with numerous concentric lines of growth and with interveming bands of striæ that are somewhat undulating. When the outer surface of the shell is exfoliated the shiny inner layers of the shell are marked by both concentric and radiating striæ.

The shell is thin and formed of a thin outer layer, and several thin inner layers or lamellæ. In some of the layers of argillaceous shale the shell has a bluish tinge with a glistening surface, often wrinkled and ridged by longitudinal compression and also compressed into transverse ridges when the shell has been distorted by movement in the shale. In some of the specimens in the sandy layers, a few concentric lines of minute punctæ occur on the posterior portion of the inner surface. A large ventral valve has a length of 15 mm. with a width of 10 mm., and a dorsal valve 11 mm. in length has a width of 8 mm. The average length of several hundred specimens of the ventral valve is from 6 to 7 mm.

The cast of the area of the pedicle valve shows it to be rather long and well extended out on the cardinal slopes. A clearly defined pedicle furrow divides it midway, and a narrow flexure line occurs about halfway between the pedicle furrow and the outer margin. The area is marked by fine striæ of growth parallel to the margin. The area of the brachial valve is short and seldom well preserved.

The cast of the interior of the valves, both in the argillaceous and sandy shale, shows almost no traces of vascular markings or muscle scars.

Observations.—When studying this species in 1901 I had a few specimens which at the time I considered to be identical with *Lingulella bella* (Walcott). During the season of 1901 S. Ward Loper collected many hundred specimens on McNeil Brook, and other localities in Cape Breton, that clearly showed that Matthew [1901a, p. 273] was correct in assigning it to a distinct species. I was not sure that his *Lingulella lens* (Matthew) was distinct, as the material from which he described and figured it was badly crushed and broken, the fragments of shell being embedded together in the limestone. None of the typical specimens show the apex of the ventral valve. The one used in illustration by Matthew [1901a, Pl. V, fig. 3a] has all the apex broken away, and the shell is somewhat compressed laterally. A photograph of this specimen of *Lingulella lens* (Matthew) is reproduced in Plate XXXIII, figure 1.

Among the collections made by Loper, there are a large number of shells crushed and crowded together very much as in the typical material of *Lingulella lens* used by Matthew. There are, however, in the accompanying shales large numbers of individual specimens which are beautifully preserved, which illustrate the outline and convexity of the shell. The series illustrates the growth of the shell, also the various forms in which it occurs owing to the difference in sediment in which it has been embedded. The material collected by Loper came from several horizons of the Upper Cambrian. Matthew [1901a, pp. 273–274] assigns "*Lingulella concinna*" to the *Dictyonema* zone, and "*Lingula lens*" to the *Parabolina* zone.

The shells in the arenaceous shales on McAdam shore are clearly *Lingulella concinna*, but in the calcareous layers the shells are different and I retain the name *lens* for them.

I received from Dr. G. Lindström a specimen from the black *Dictyonema* shales of Skåne, Sweden, labeled "*Lingulella nathorsti* Linnarsson." This is evidently an accident, as that species occurs only in the Lower Cambrian and the specimen is a broader shell much like that of *L. concinna* of Cape Breton. With our present information it is provisionally referred to *L. concinna*.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**3h**) Shale and shaly limestone on McNeil Brook, 1.5 miles (2.4 km.) east of Marion Bridge; (**307** [*Matthew, 1903, p. 204*]) *shales of Division C3c of Matthew on McLeod Brook (=Barachois River);* (**10c**) shales on west side of Barachois River; (**10n**) shale in ravine on east side of Barachois Glen, 3 miles (4.8 km.) from Barachois; (**10e, 10f, 10g,** and **10h**) shale on small east branch of Barachois River, about 0.75 mile (1.2 km.) north of the crossroad from Boisdale to Upper Leitches Creek; (**8d** and **372**) shale at Upper Leitches Creek; (**10m** and **372a**) shale 2 miles (3.2 km.) south of the Boisdale Road from Upper Leitches Creek; (**10d** and **10i**) shale in high bank on west side of Barachois River, just north of the Boisdale Road; (**13h**) shale on east bank of Barachois River, 1.5 miles

(2.4 km.) north of Boisdale; (**101**) shale on east bank of Barachois River, 6 miles (9.6 km.) from Little Bras d'Or Lake; (**3q**) shale in Barachois Glen, 4 miles (6.4 km.) south of Little Bras d'Or Lake; (**3p** and **372b**) shale in ravine 0.5 mile (0.8 km.) north of McMullins, on the crossroad to Boisdale; (**16o**) shales on McMullins Brook, in the east Boisdale district; (**3o** and **372c**) shale in ravine east of the railroad, just south of Barachois; and (**372d**) shale on McAdam shore on East Bay, east of Bras d'Or Lake; all in eastern Cape Breton, Nova Scotia.

Middle Cambrian: (**3i**) Compact, fine-grained, thin-bedded, gray sandstone of the *Paradoxides* zone, on McLean Brook, 1 mile (1.6 km.) east of McCodrum Brook and 1.5 miles (2.4 km.) west of Marion Bridge, eastern Cape Breton, Nova Scotia.

A specimen from the following locality is provisionally referred to *Lingulella concinna:*

Upper? Cambrian: (**310h**) Shale collected somewhere (probably Fogelsång), in the old Province of Skåne, now the Provinces of Malmöhus and Christianstad, Sweden.

Lingulella cuneola (Whitfield).

Plate XXVII, figures 7, 7a–b.

Lingulepis cuneolus Whitfield, 1877, U. S. Geog. and Geol. Survey Rocky Mtn. Region, Rept. Geology Black Hills of Dakota; Prelim. Rept., pp. 8–9. (Described and discussed as below as a new species.)

Lingulepis cuneolus Whitfield, 1880, U. S. Geog. and Geol. Survey Rocky Mtn. Region, Rept. Geology and Resources Black Hills of Dakota, by Newton and Jenney, p. 336, Pl. II, figs. 5 and 6. (Description copied from preceding reference. The specimen represented by fig. 6 is redrawn in this monograph, Pl. XXVII, fig. 7.)

Obolus (*Lingulella*) *cuneolus* (Whitfield), Walcott, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, p. 443. (Merely changes generic reference.)

The original description by Whitfield follows:

Shells small, rather below the medium size, triangularly ovate in outline or sometimes subcuneate; ventral valve triangularly ovate, with a sharp somewhat pointed beak, the width and length about as three and four, and the point of greatest width near the lower third of the length of the valve; cardinal slopes abrupt, scarcely convex; basal line rounded at the sides, but nearly straight in the middle; surface of the valve strongly convex, becoming almost subangular in the upper part; dorsal valve much shorter proportionately than the ventral, the length but little exceeding the width; side and base more rounded and the beak truncate; surface distinctly convex.

Surface of the shell apparently smooth, but usually exfoliated, in which condition a few fine radiating lines are visible.

This shell differs from *L. pinnaformis* Owen in size and in the more distinctly cuneate form of the ventral valve. At first sight it might be taken for the young of that species, but a little critical examination soon reveals marked distinctions in the truncation of the front margin, and especially in the form of the cardinal slopes, which are rounded and never concave, as in almost all ventral valves of that species. In consequence of this latter feature the beak does not appear so attenuated as in that one, although proportionately quite as long. In the general surface characters and form of the valves it corresponds with the genus *Lingulepis*, although we have not been able to distinguish the muscular impressions.

Were it not for the difference in the size of the shells we should be inclined to think this might be the species figured by Messrs. Meek and Hayden [1865, p. 3, Pl. I, figs. 1a–b] as *Lingulepis dakotensis;* but as their figures appear to be of the natural size, we should suppose it to be very distinct, as all the specimens of our shell noticed have been small, none exceeding one-fourth of an inch in length.

Observations.—This species does not appear to be correctly referred to *Lingulepis*. In outline it resembles some of the cuneate forms of *Lingulella*, and in its thick laminated shell it approaches *Lingulella phaon* (Walcott) (Pl. XXVI). Like that species, it has a thick outer layer and strong, radially striated inner layers, and numerous lamellæ slightly oblique to the outer layer over the anterior portions of the shell, especially about the anterior and lateral margins. Most of the specimens are in the form of partial casts, only a portion of the outer shell adhering to the cast.

The form of the ventral valve approaches that of some of the broader shells of *Lingulella perattenuata* (Whitfield) (Pl. XXI). It differs, however, in being more cuneate. Except for the somewhat straighter slope of the sides toward the beak it might be identified with *Lingulella acutangula* (Roemer) (Pl. XVII). Although fairly large collections were made from the Cambrian formations in the Black Hills during the field season of 1897, no specimens were found that could be definitely identified as belonging to this species, the only material available for study being that in the original collections of W. P. Jenney.

Formation and locality.—**Middle Cambrian**: (**355**) Sandstones in Red Canyon Creek, southwest side of the Black Hills, South Dakota.

Specimens somewhat doubtfully referred to this species occur at the following locality:

Middle Cambrian: (167) Sandstone beneath limestone and resting on the pre-Cambrian in a bluff 9 miles (14.4 km.) west of Custer, Black Hills, South Dakota.

Lingulella damesi (Walcott).[a]

Plate XXXIX, figures 8, 8a–c.

Obolus (*Lingulella*) *damesi* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 329. (Characterized as below as a new species.)

The general descriptions of *Obolus chinensis* (Walcott) (p. 387) and *Lingulella prima* (Hall) (p. 526) apply so closely to this species that it does not appear necessary to do more than call attention to the points in which they differ. From *Obolus chinensis* (Pl. XXXIX) this species varies in having a more elongate, acuminate ventral valve and a more ovate dorsal valve; the valves are also less convex. From *Lingulella prima* (Pl. XXVII) it differs in the more gradual curvature of the sides from the apex to the front margin, in this respect resembling some varieties of *L. ferruginea* Salter (Pl. XXIX). The average size of the ventral valve is about 5 mm. in length by 3.5 mm. in width.

The specific name was given in honor of Dr. W. Dames.

Formation and locality.—**Middle Cambrian**: (**C7**) Lower limestone member of the Kiulung group [Blackwelder, 1907, pp. 37 and 39 (last list of fossils), and fig. 8a (bed 33), p. 29], 2.2 miles (3.5 km.) southwest of Yenchuang; and (**C10**) *lower shale member of the Kiulung group [Blackwelder, 1907, pp. 37 and 40 (part of 3d list of fossils), and fig. 8a (bed 35), p. 29], about 3 miles (4.8 km.) southwest of Yenchuang;* both in the Sintai district, Shantung, China.

A shell which may be a variety of this species occurs at the following locality:

Upper Cambrian: (**C64**) Upper limestone member of the Kiulung group [Blackwelder, 1907, pp. 37 and 42 (first list of fossils), and fig. 10 (bed 20), p. 38], 2.7 miles (4.3 km.) southwest of Yenchuang, Sintai district, Shantung, China.

Lingulella davidsoni (Barrande).

Plate XXXII, figures 1, 1a–e.

Lingula davidsoni Barrande, 1879, Système silurien du centre de la Bohême, vol. 5, Pl. CIV, figs. viii: 1–4. (Not described, but figured as a new species. Pl. CIV, figs. viii: 1A, 1b, 3A, 3b, 4E, and 4 are reproduced in this monograph, Pl. XXXII, figs. 1, 1a–e, respectively.)

In the absence of specimens for study an opinion of the generic relations of this fine species is necessarily based on the illustrations given by Barrande. Comparing Plate XXXII, figures 1 and 1b, with Plate XVII, figure 1a, we note at once the similarity between *Lingulella davidsoni* and *L. acutangula* (Roemer) in their general form and the character of their areas as far as shown for *Lingulella davidsoni*. Fragments of the exterior shell of the latter (Pl. XXXII, fig. 1b) may be compared with the exterior surface of the former (Pl. XVII, fig. 1). The dark oval spots in front of the area in figure 1d may be of importance, or they may represent only a depression on each side of the median ridge such as often occurs in compressed shells. If this species is a typical *Lingulella*, it is one of the last of its race, occurring as it does in Étage d4 of Barrande's section.

The specific name was given in honor of Thos. Davidson.

Formation and locality.—**Ordovician**: (**303m**) *Étage d4 at Lieben;* (**303n**) Étage d4 at Wraž; and (**303o**) Étage d4 at Lodenitz; all [Barrande, 1879b, Pl. CIV] in Bohemia, Austria-Hungary.

Lingulella davisi (McCoy).

Plate XXX, figures 2, 2a; Plate XXXI, figures 6, 6a–h.

Lingula sp. Davis, 1846, Quart. Jour. Geol. Soc. London, vol. 2, pt. 1, p. 70. (Mentioned only.)

Not *Lingula ovata* McCoy, 1846, Silurian Fossils of Ireland, p. 24, Pl. III, fig. 1. (Described and discussed. This species is not taken up in this monograph.)

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[a] Better preserved and more complete series of specimens of this species collected by Dr. J. P. Iddings, in Manchuria, indicate that the form bears a closer relationship to *Obolus* than to *Lingulella*. In the volume on Paleontology of Willis's work on Research in China (Carnegie Institution of Washington) the species will be described and figured under the title, *Obolus damesi* (Walcott).

Lingula sp. SEDGWICK, 1847, Quart. Jour. Geol. Soc. London, vol. 3, pt. 1, pp. 140, 143, and 147. (Mentioned only.)

Tellinomya lingulæ-comes McCOY [not SALTER], 1851, Annals and Mag. Nat. Hist., 2d ser., vol. 7, p. 56. (Described and discussed. Salter's species is not a brachiopod and is not taken up in this monograph.)

Lingula davisi McCOY, 1851, idem, vol. 8, pp. 405–406. (Described and discussed as a new species.)

Lingula davisi McCOY, 1854, British Paleozoic Fossils, p. 252, Pl. IL, figs. 7, 7a–b. (Description copied from preceding reference and one locality added.)

Lingula ovata McCOY (in part), 1854, idem, p. 254, Pl. IL, figs. 6 and 6a. (Described and discussed. Specimens of *Lingulella davisi* were included with "*Lingula ovata*" in this description. The specimens belonging with *Lingula ovata* are not taken up in this monograph.)

Tellinomya lingulicomes McCOY [not SALTER], 1854, idem, p. 274, Pl. IX, fig. 18. (Described and discussed almost as in McCoy, 1851a, p. 56.)

Lingulella davisi (McCoy), SALTER, 1866, Mem. Geol. Survey Great Britain, vol. 3, pp. 333–334, Pl. II, figs. 7–12, Pl. IV, figs. 14 and 14a. (Described in Latin and discussed in English.)

Lingulella davisii (McCoy), DAVIDSON, 1866, British Fossil Brachiopoda, vol. 3, pt. 7, No. 1, pp. 56 and 57, Pl. IV, figs. 1–16. (Described and discussed. Figs 9, 3, 7, 6, 4, 5, 13, 14, and 15 are copied from Salter, 1866b, Pl. II, figs. 7–12, and Pl. IV, figs. 14 and 14a, respectively. Figs. 10, 11, and 12 are reproduced in this monograph, Pl. XXXI, figs. 6, 6a–b, respectively.)

Lingulella davisii (McCoy), SALTER, 1867, Siluria, by Murchison, 4th ed., pp. 44 (and footnote) and 52; fossils (5) fig. 1; fossils (10), fig. 11. (Mentioned.)

Lingulella davisi (McCoy), DAVIDSON, 1868, Geol. Mag., vol. 5, pp. 304 and 306, Pl. XV, figs. 13–15. (Species discussed.)

Lingulella davisi (McCoy), MEEK, 1871, Proc. Acad. Nat. Sci. Philadelphia for 1871, vol. 23, pp. 186–187, fig. 2, p. 185. (Discussed in discussion of "*Lingulella lamborni*." Fig. 2 is copied from Davidson, 1866, Pl. IV, fig. 14.)

Lingulella davisii (McCoy), HALL, 1873, Twenty-third Ann. Rept. New York State Cab. Nat. Hist., Pl. XIII, fig. 4. (No text reference. Fig. 4 is copied from Davidson, 1866, Pl. IV, fig. 16.)

Lingulella davisii (McCoy), ROEMER, 1876, Lethæa geognostica, pt. 1, Lethæa palæozoica, Atlas, Pl. II, figs. 5a–c. (No text reference.)

Lingulella davisii (McCoy), SALTER and ETHERIDGE, 1881, Mem. Geol. Survey Great Britain, vol. 3, 2d ed., pp. 537–538, Pl. II, figs. 7–12; Pl. IV, figs. 14 and 14a. (Copied from Salter, 1866b, p. 333, Pl. II, figs. 7–12; Pl. IV, figs. 14 and 14a.)

Lingulella sp. KAYSER, 1883, China, by Richthofen, vol. 4, pp. 35–36, Pl. III, fig. 3. (Described in German. Fig. 3 is reproduced in this monograph, Pl. XXX, fig. 2a.)

Lingulella davisi (McCoy), HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 232, fig. 239. (No text reference, figure copied from Salter, 1866b, Pl. IV, fig. 14a.)

Lingulella davisi (McCoy), HALL and CLARKE, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, p. 548, fig. 239. (Copy of preceding reference.)

Lingulella davisi (McCoy), HALL and CLARKE, 1892, Nat. Hist. New York Paleontology, vol. 8, pt. 1, pp. 56 and 57, fig. 18. (Discussed in the text and figure copied from Salter, 1866b, Pl. IV, fig. 14a.)

Lingulella cf. *davisii* (McCoy), KAYSER, 1897, Zeitschr. Deutsch. geol. Gesell. for 1897, Bd. 49, Heft 2, No. 2, p. 280, Pl. VII, fig. 6. (Characterized. Fig. 6 is reproduced in this monograph, Pl. XXX, fig. 2.)

Obolus (*Lingulella*) *davisii* (McCoy), WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 394 and 395, Pl. XXVII, figs. 1–5. (Mentioned in discussion of genus *Lingulella*. The specimens represented by figs. 1, 2, 4, and 5 are redrawn in this monograph, Pl. XXX, figs. 6f, 6d, 6e, and 6h, respectively.)

Lingulella cf. *davisii* (McCoy), MATTHEW, 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 5, No. 20, pp. 407–408. (Described.)

Lingulella cf. *davisii* (McCoy), MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 203. (Copied from preceding reference.)

The characters of this species, as far as known to me, are illustrated on Plate XXXI, and reference is made to some of them in the description of the genus *Lingulella*. Many interesting observations are given by Davidson [1866, p. 57] in his description of the species and its occurrence at various localities in Wales.

E. Kayser [1897, Pl. VII, fig. 6] illustrates a dorsal ? valve from the Cambrian beds of Iruya, Province of Salta, Argentina, which he compares with *Lingulella davisi*. The specimen indicates the presence of a form that may be the representative of *L. davisi*, but it may be a new form, or possibly identical with some one of the species of the Atlantic basin fauna found in New Brunswick or Newfoundland. The original figure is reproduced on Plate XXX, figure 2.

The form illustrated by Kayser [1883, Pl. III, fig. 3] in the report on the Cambrian brachiopods of Liaotung is also suggestive of *Lingulella davisi*, as may be seen by comparing a copy of Kayser's figure on Plate XXX with the illustration of *L. davisi* on Plate XXXI, figure 2a.

It should also be compared with *Lingulella ampla* (Owen) (Pl. XXVIII, figs. 1, 1a–j) of the Mississippi Valley.

The specific name was given in honor of Mr. J. E. Davis, who first called attention to the species.

FORMATION AND LOCALITY.[a]—**Ordovician**: (**304n**) "Coniston (Bala) limestone" [McCoy, 1854, p. 254], at Coniston, Lancashire, England.

Upper Cambrian: (**366d**) Lower *Lingula* flags at Carnedd Filiast, Bangor; (**366e**) Lower *Lingula* flags at Marchillyn-mawr, Llanberis; both [Davidson, 1866, p. 57] in Carnarvonshire, North Wales.

Lower *Lingula* flags at the following localities: (**366f**) Ffestiniog; (**366g**) Dolgelly; (**366h**) Pen-y-Bryn, 5 miles (8 km.) north of Dolgelly; (**366i**) Llyn Dywarchen; (**366j**) Pont Nant-y-Lladron, on the Bala Road; (**366k**)[b] *Penmorfa;* (**366 l**)[b] *Tremadoc;* and (**366m**)[b] *near Nant-y-Groes, west of Bala;* all [Davidson, 1866, p. 57] in Merionethshire, North Wales.

(**366n**) Lower *Lingula* flags at Portmadoc; (**366o**) "Bala schists" [McCoy, 1854, p. 254] at Bryn Melyn, near Bala; (**366p** [Davidson, 1866, p. 57]) Upper Tremadoc beds at Deudraeth; (**366q** [Davidson, 1866, p. 57]) Upper Tremadoc beds at Garth, opposite Portmadoc; and (**366a**) upper portion of Middle *Lingula* flags, 6 miles (9.6 km.) east of Ffestiniog; all in Merionethshire, North Wales.

(**366r**) Shale 2 miles (3.2 km.) north of Builth, Brecknockshire; and (**366** [Davidson, 1866, p. 57]) at Whitesand Bay, near St. Davids Head, Pembrokeshire; both in South Wales.

(**318m** [Davidson, 1866, p. 57]) Near the base of the lower black slates, in the Waterfall Valley near Maentwrog, North Wales.

(**307a** [Matthew, 1903, p. 203]) Shales of Division C3c2 of Matthew on McLeod Brook (=Barachois River), near Boisdale, eastern Cape Breton, Nova Scotia, Canada.

(**389d** [Kayser, 1897, p. 280]) Iruya, Province of Salta, Argentina, South America.

(**332** [Kayser, 1883, p. 35]) Limestones at Saimaki, Liaotung, China.

LINGULELLA DELGADOI n. sp.

Plate XXIX, figures 6, 6a–c.

Lingulepis acuminata meeki DELGADO [not WALCOTT], 1904, Communicações Commissão Serviço Geol. Portugal, tome 5, fasc. 2, pp. 366–367, Pl. IV, figs. 17 and 27; Pl. VI, fig. 9. (Characterized and discussed in French. A photograph of the specimen represented by fig. 27 (reverse view) is reproduced in this monograph, Pl. XXIX, fig. 6b.)

Lingulella granvillensis DELGADO [not WALCOTT], 1904, idem, pp. 367–368, Pl. IV, figs. 15, 16, 18, and 19. (Discussed in French. Photographs of the specimens represented by figs. 16 and 18 are reproduced in this monograph, Pl. XXIX, figs. 6 and 6a, respectively.)

Lingulella ferruginea DELGADO [not SALTER], 1904, idem, pp. 368–369, Pl. IV, figs. 20 and 21; Pl. VI, fig. 2. (Discussed in French.)

Lingulella cf. *linguloides* Matthew, DELGADO, 1904, idem, pp. 369–370, Pl. IV, fig. 14. (Described and discussed in French. A photograph of the specimen represented by fig. 14 (reverse view) is reproduced in this monograph, Pl. XXIX, fig. 6c.)

This is one of the abundant and variable forms in the fauna of the Province of Alemtejo. It may be compared in this respect with the widely distributed *Lingulella ferruginea* Salter. Delgado compares different phases of it to three species, two of which, *L. ferruginea* Salter and *L.* cf. *linguloides* Matthew, I think are specifically the same. *Lingulella granvillensis* Walcott has the same flattening along the median line of the ventral valve. As stated by Delgado [1904, p. 367], there is a strong resemblance between the representatives of the two forms, but I think that it is better to give the Portuguese form a distinct specific name than to identify it with the American species.

Delgado sent me enlarged photographs of the specimens of the three varieties which he recognized and illustrated, and I have reproduced four of them, Plate XXIX, figures 6, 6a–c.

It is quite probable that if I had all of Delgado's specimens to study a different disposition would be made of the specific references, but with present knowledge and experience of the variability of species like this, especially where the shells have been more or less misshaped by lateral movement in the "schists," I prefer to combine the forms in one species.

The specific name is given in honor of the late Dr. J. F. Nery Delgado.

FORMATION AND LOCALITY.—**Lower Cambrian**: (**351** [Delgado, 1904, pp. 366–369]) Shales at Monte de Valbom, northeast of Villa Boim, Province of Alemtejo, Portugal.

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[a] The species also occurs in Locality **317b** (p. 248).

[b] Davidson does not state which of the three localities (**366k**, **366 l**, or **366m**) is the type.

Lingulella desiderata (Walcott).

Plate XX, figures 4, 4a–c, 5, 5a–j.

Obolus (*Lingulella*) *desideratus* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 399–400. (Described and discussed as a new species.)

Obolus (*Lingulella*) *desideratus* Walcott (in part), 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, pp. 445–446, Pl. LX, fig. 2 (not 2a). (Described essentially as below, and discussed. The specimen represented by fig. 2 is redrawn in this monograph, Pl. XX, fig. 4. The specimen represented by fig. 2a is referred in this monograph to *Obolus rotundatus*, Pl. XX, fig. 2e.)

Dicellomus nanus Walcott (in part) [not Meek and Hayden], 1899, idem, p. 447, Pl. LX, fig. 3 (not figs. 3a–d). (Mentioned. The specimen represented by fig. 3 is redrawn in this monograph, Pl. XX, fig. 5j. The specimens represented by figs. 3a–d are referred in this monograph to *Dicellomus nanus*.)

Shell small, subovate, with the ventral valve obtusely acuminate, and the dorsal valve broadly ovate. Valves are strongly convex, with the ventral valve fully as much so as the dorsal. There is a slight variation in the outline of the valves, some being slightly more rounded posteriorly than others.

The surface of the shell is marked by fine, concentric lines of growth, and between them very fine, slightly irregular striæ; a few rather narrow indistinct undulations radiate from the umbo toward the front and lateral margins; when the outer shell is partly exfoliated the outer surface of the inner layer is marked by very fine indistinct radiating striæ; there are a few traces of small, scattered pits or punctæ on the inner surface. The shell is thin and formed of an outer layer and one or more inner layers or lamellæ.

The average length of the ventral valve is about 4 mm.; width, 3 mm. A dorsal valve 3.5 mm. long has a width of 3 mm.

A cast of the interior of a ventral valve shows an area of medium length, divided midway by a narrow, clearly defined pedicle groove. The area of the dorsal valve is short. Nothing is known of the interior of the ventral valve, but in a cast of a dorsal valve there are traces of the main vascular sinuses, central median septum, and the central muscle scars.

Observations.—This species may be compared with the Middle Cambrian *Lingulella ferruginea* Salter of the Atlantic basin faunas, and *L. similis* (Walcott), of the Black Hills, upper Mississippi Valley, and Appalachian faunas. *Lingulella similis* is more convex and narrower, and *L. manticula* (White) is considerably more acuminate. Compared with the Rocky Mountain species it is intermediate between *L. manticula* and *L. rotunda* (Matthew). It may also be compared with *L. granvillensis* Walcott of the *Olenellus* fauna of eastern New York, and *L. iole* (Billings) of the Lower Ordovician fauna of Newfoundland. It is distinguished from *L. granvillensis* by its more regularly rounded anterior margin.

The specimens represented by Plate XX, figures 4b, 4c, and 5j, are broader proportionately than the typical specimens represented by Plate XX, figures 4 and 4a, but they occur at the same geological horizon in the Eureka district, Nevada. What appears to be the same, or a closely related species, occurs in the upper beds of the Secret Canyon shale in the Eureka district, Nevada.

A form that appears to be identical occurs in considerable abundance in Alabama and Tennessee. The similarity in form between the specimens from Wyoming and Nevada, and those from Alabama and Tennessee is shown by Plate XX, figures 4, 4a–c, of the typical specimens, and Plate XX, figures 5, 5a–i, of their representatives in the Appalachian region. This similarity is even more striking when the specimens are compared directly with one another, and some allowance made for the fact that the Appalachian specimens have all been more or less compressed.

A small shell that appears to be identical with this species occurs in the red sandstone and argillaceous shale of the Lower Ordovician of Colorado. The specimens from Trout Creek, below Bergen Park, are much like those from the Gallatin Range in Montana and the same species of *Billingsella* is associated with them. At Cement Creek, 10 miles (16.1 km.) southeast of Crested Butte, Colorado, the shells occur in a fine conglomerate and coarse sandstone

associated with a species of *Bathyurus* much like that from the beds containing *Lingulella desiderata* at Trout Creek.

FORMATION AND LOCALITY.—**Lower Ordovician:** (**360**) Red siliceous limestone near Colorado Springs; (**186**) near line of contact between red and gray Ordovician limestones, in red siliceous limestone about 30 feet (9.1 m.) above the pre-Cambrian rocks, Williams Canyon, Manitou; (**187**) red siliceous limestone 105 to 122 feet (32 to 36.7 m.) above the pre-Cambrian rocks, 2 miles (3.2 km.) below Manitou Park Hotel; (**360a**) red siliceous limestone on west side of Trout Creek, below Bergen Park, 7 miles (11.2 km.) north-northwest of Manitou; all in El Paso County, Colorado.

(**360b**) Red siliceous limestone on Cement Creek, 3 miles (4.8 km.) north of Hot Springs, Ouray County; and (**360c**) red siliceous limestone about 10 miles (16.1 km.) southeast of Crested Butte, Elk Range; both in Colorado.

Upper Cambrian: (**161**) Limestone on the south side of West Gallatin (Gallatin) River, northwest of Hamilton, on the north side of the Gallatin Valley, Gallatin County, Montana.

(**7x, 7y,** and **7z**) Limestone of the Emigrant formation [Turner, 1902, p. 265], about 2.5 miles (4 km.) southeast of the summit of Emigrant Pass, Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County; (**8n**) limestone about 500 feet (152 m.) up in the limestones east of Swallow Ranch, west side of Snake Range, 20 miles (32.2 km.) south of Osceola, White Pine County; (**313**) limestone 0.75 mile (1.2 km.) east-northeast of McGill post office, White Pine County; and (**61**) limestone in the Dunderberg shale [Walcott, 1908f, p. 184], a little south of the Hamburg mine, Eureka district [Hague, 1892, Atlas], Eureka County; all in Nevada.

(**30h**) About 350 feet (106.7 m.) above the Middle Cambrian and 2,950 feet (899.2 m.) below the top of the Upper Cambrian near the base of the arenaceous limestones forming 2a of the Orr formation [Walcott, 1908f, p. 177]; and (**30j** and **30k**) 950 and 1,150 feet (289.6 and 350.5 m.) above the Middle Cambrian and 2,450 and 2,175 feet (746.8 and 662.9 m.) below the top of the Upper Cambrian, in the arenaceous shales and limestone forming 1e of the Orr formation [Walcott, 1908f, p. 176]; all on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah.

(**15d**)[a] Thin-bedded blue limestone near Cave Spring on the east side of the Fish Spring Range, about 4 miles (6.4 km.) south of the J. J. Thomas ranch, Juab County; (**34t**) limestone 1.5 miles (2.4 km.) northwest of Wahwah Springs, about 80 feet (24.4 m.) below the highest point on the north side of the road at Cane Pass, Wahwah Mountains, Beaver County; (**32g**) about 2,575 feet (784.9 m.) above the Cambrian quartzitic sandstones in a blue limestone about 2 miles (3.2 km.) southeast of Muskrat Springs on the northwest face of Grantsville Peak, Stansbury Range, Tooele County; (**54j**) about 700 feet (213.4 m.) above the Middle Cambrian and 525 feet (160 m.) below the top of the Upper Cambrian in the arenaceous limestones forming 2c of the St. Charles formation [Walcott, 1908f, p. 192], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County; all in Utah.

(**5a** and **54t**) Limestones of the St. Charles formation [Walcott, 1908a, p. 6] about 250 feet (76 m.) above the Middle Cambrian on the north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

(**93** and **93o**) Shales and limestones at the base of the Knox dolomite near Jordan's, just below the ford on Cowan Creek, about 8 miles (12.8 km.) southeast of Center; (**93a**)[b] same horizon as Locality 93 on Terrapin Creek road from Center to Amberson; (**94o**) same horizon as Locality 93, 0.25 mile (0.4 km.) beyond Givens Ford, on Cowan Creek, about 8 miles (12.8 km.) southeast of Center; and (**94xx**) same horizon as Locality 93 at Givens mill, on Cowan Creek, about 8 miles (12.8 km.) southeast of Center; all in Cherokee County, Alabama.

(**361**) Shaly limestone in suburb of Attalla, Etowah County, Alabama.

(**96**) Limestones near the ford on the Cedartown road, 1.5 miles (2.4 km.) south of Rome, Floyd County; and (**362**) shales in the Oothkalooga Valley, Bartow County; both in Georgia.

(**107u** and **107o**) Limestones and shales at the base of the Knox dolomite, west of the top of Copper Ridge, near the Southern Railway cut, about 10 miles (16.1 km.) northwest of Knoxville [Keith, 1896b, areal geology sheet], Knox County, Tennessee.

(**122a**)[c] Shale at the headwaters of Forgey Creek, northwestern part of the Greeneville quadrangle (U. S. Geol. Survey), Hawkins County, Tennessee.

Upper? Cambrian: (**56**) Limestone at Sierra Springs, eastern base of Lookout Mountain, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

Middle? Cambrian: (**313c**) Limestone about 12 miles (19.3 km.) west-southwest of Alpha Station, Eureka County, Nevada.

Middle Cambrian: (**57**) Shaly Eldorado limestone [Walcott, 1908f, p. 184] at the 700-foot (213.4 m.) level of the Richmond mine, Ruby Hill [Hague, 1892, p. 43, and Pl. I, opposite p. 116]; (**57b**) limestones at the north end of Mineral Hill, just south of Ruby Hill [Hague, 1892, p. 43, and Pl. I, opposite p. 116]; (**60**) limestones in upper beds of Secret Canyon shale, across the canyon from the dump of the old Richmond mine shaft; and (**58**) shaly limestones in upper beds of Secret Canyon shale, east side of New York and Secret canyons; all in the Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

(**313b**) Limestone 3 miles (4.8 km.) north-northeast of Schellbourne, Schell Creek Range, White Pine County, Nevada.

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[a] This species also occurs at Locality **34i** (p. 196).

[b] The species is somewhat doubtfully identified from this locality.

[c] This species also occurs at Locality **122** (p. 223).

(**15x**) Limestones near the middle of the Fish Spring Range, near the line between Juab and Tooele counties; and (**15p**) limestones near the north end of the Fish Spring Range, Tooele County; both in Utah.

(**5b**) Dark blue-gray Langston limestone [Walcott, 1908f, p. 198], just above the Cambrian quartzitic sandstones, on the north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County; (**59f**) limestones immediately underlying the Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], in a saddle north of the creek which flows into Mill Canyon from the west, about 5 miles (8 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County; and (**55c** and **163**) Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], about 50 feet (15.2 m.) above the Brigham quartzite and 2,755 feet (839.7 m.) below the Upper Cambrian, in a ravine running up into Danish Flat from Mill Canyon, about 6 miles (9.6 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County; all in Idaho.

(**55e**) Spence shale member of the Ute limestone about 100 feet (30.5 m.) above the Brigham quartzite [Walcott, 1908f, p. 197], at the mouth of the first small canyon south of Wasatch Canyon, east of Lakeview ranch, 5 miles (8 km.) north of Brigham, Boxelder County, Utah.

(**311** and **54h**) About 3,140 feet (957.1 m.) above the Brigham quartzite and 1,050 feet (320 m.) below the Upper Cambrian in the limestones forming 1a of the Bloomington formation [Walcott, 1908f, p. 194]; and (**541**) about 500 feet (152.4 m.) above the Brigham quartzite and 3,700 feet (1,127.8 m.) below the Upper Cambrian in the Spence shale member of the Ute limestone [Walcott, 1908f, p. 197]; both in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

(**3021**) *Limestone in the Gallatin Range;* and (**302b**) limestone near Crowfoot Ridge, Gallatin quadrangle (U. S. Geol. Survey); both in Yellowstone National Park, Wyoming.

(**5f**) Limestones interbedded in the Wolsey shale [Weed, 1900, p. 285], in Meagher County on the road to Wolsey, about 4 miles (6.4 km.) south of the divide at the head of Sawmill Creek and 11 miles (17.7 km.) south of Neihart, Little Belt Mountains quadrangle (U. S. Geol. Survey), Cascade County, Montana.

(**581**) About 1,830 feet (557.8 m.) above the Lower Cambrian in the limestone forming 3b of the Stephen formation [Walcott, 1908c, p. 238(7)], on the east side of Mount Stephen about 3,000 feet (914.4 m.) above the Canadian Pacific Railway track, 3.5 miles (5.6 km.) east of Field, British Columbia.

(**88a**) Limestone about 100 feet (30.5 m.) above the quartzitic sandstone at the base of the Cambrian, in the northern suburbs of Deadwood, in the Black Hills, South Dakota.

(**9**) Limestone on southeastern slope of ridge 1 mile (1.6 km.) north of the northwest corner of Harlans Knob, about 4 miles (6.4 km.) northeast of Rogersville [Keith, 1905, areal geology sheet]; (**9a**) same horizon as locality No. 9 in limestone on the south shore of Holston River at Melinda Ferry, 5 miles (8 km.) southwest of Rogersville [Keith, 1896a, areal geology sheet]; (**101a** and **101b**) Rogersville shale near the schoolhouse, 3.5 miles (5.6 km.) southwest of Rogersville, on the road to Melinda Ferry; (**103b**) third limestone south of the ridge of sandstone in the Rome formation ("Town Knobs"), on the road from Rogersville to Dodson Ford, near the line between the Morristown and Greeneville quadrangles (U. S. Geol. Survey); and (**121**) Rogersville shale, road just east of Harlan Knob, 4 miles (6.4 km.) northeast of Rogersville [Keith, 1905, areal geology sheet]; all in Hawkins County, Tennessee.

(**117**) Shales on the road north from Greeneville, Greene County, Tennessee.

(**369g**) Shales at Bonneterre, St. Francois County, Missouri.

(**90b**) Conasauga limestone, in cut on the Louisville and Nashville Railroad, near Woodstock, Bibb County; (**16**) Conasauga ("Coosa") limestone, Blountsville Valley, Blount County; and (**139**) limestone on Hokes Bluff road, north of the chert outcrop, 5 miles (8 km.) east of Gadsden, Etowah County; all in Alabama.

Specimens somewhat doubtfully referred to this species occur at the following locality:

Middle Cambrian: (**107a**) Shale in railroad cut in Bull Run, northwest of Copper Ridge [Keith, 1896b, areal geology sheet], 11 miles (17.7 km.) northwest of Knoxville, Knox County, Tennessee.

Lingulella dubia (Walcott).

Plate XXIV, figures 4, 4a.

Lingulella ella Walcott (in part) [not Hall and Whitfield], 1886, Bull. U. S. Geol. Survey No. 30, pp. 97–98, Pl. VIII, figs. 4b and 4c (not Pl. VII, fig. 2, or Pl. VIII, figs. 4, 4a, 4d, and 4e). (Original description, Hall and Whitfield, 1887, p. 232, copied and species described and discussed. The specimens represented by figs. 4b and 4c are redrawn in this monograph, Pl. XXIV, figs. 4 and 4a, respectively. The specimens represented by Pl. VII, fig. 2, and Pl. VIII, figs. 4, 4a, 4d, and 4e, are referred in this monograph to *Obolus* (*Westonia*) *ella*.)

Lingulella ella Walcott (in part) [not Hall and Whitfield], 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 607, Pl. LXVII, figs. 2c–d (not figs. 2, 2a–b). (Mentioned. Figs 2c and 2d are copied from Walcott, 1886b, Pl. VIII, figs. 4c and 4b, respectively. The specimens represented by figs. 2c and 2d are redrawn in this monograph, Pl. XXIV, figs. 4 and 4a, respectively. The specimens represented by figs. 2, 2a–b, and 2e are referred in this monograph to *Obolus* (*Westonia*) *ella*.)

Lingulella ella Hall and Clarke (in part) [not Hall and Whitfield], 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 58, fig. 20 (not figs. 19 and 21). (Mentioned in the text. Fig. 20 is copied from Walcott, 1891a, Pl. LXVII, fig. 2c. The specimens represented by figs. 19 and 21 are referred in this monograph to *Obolus* (*Westonia*) *ella*.)

Obolus (*Lingulella*) *dubius* WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 401. (Described and discussed essentially as below as a new species.)

Lingulella genei PACK, 1906, Jour. Geology, vol. 14, No. 4, p. 295, Pl. I, figs. 3, 3a–b. (Described and discussed as a new species.)

This is a small shell associated with *Obolus* (*Westonia*) *ella* (Hall and Whitfield). It occurs in the form of casts in argillaceous shale, no traces of the shell substance remaining. The ventral valve averages about 3 mm. in length, and the dorsal valves are a little shorter. A cast of the interior of the ventral valve shows the visceral cavity (v), and an unusually strong main vascular sinus (vs) on each side. Only one specimen shows these characters as illustrated by Plate XXIV, figure 4; others only faintly indicate them.

This dorsal valve is rounded ovate, and the cast of its interior shows a very short area that extends well out on the cardinal slopes. The interior markings are a portion of the main vascular sinuses, which, in their form and extension, somewhat resemble those of the dorsal valve of *O.* (*W.*) *chuarensis* (Walcott). The only muscle scars preserved are the anterior laterals of the dorsal valve.

As far as can be determined from the casts, the outer surface is marked by lines of growth and fine, slightly undulating concentric striæ.

Observations.—At first I thought the specimens now referred to this species were the young *Obolus* (*Westonia*) *ella*, and so illustrated them [1891a, Pl. LXVII, figs. 2c and 2d]. There is still considerable doubt as to their specific relations, but in view of the very distinct interior markings I have referred them to a new species.

The form described by F. J. Pack [1906, p. 295] as "*Lingulella genei*" comes from the same locality and band of shale as *L. dubia*, and has the same form and strong interior markings. Some of Pack's specimens show the cast of the exterior surface. This is marked by the very fine, concentric, slightly undulating lines so typical of *Lingulella*. The best-preserved casts of the surface do not present the characteristics of the surface of *Obolus* (*Westonia*) *ella*.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**31**) *Shales at the Chisholm mine, southwest slope of Ely Mountains;* and (**333** [Pack, 1906, p. 295]) shales on the dump of the Abe Lincoln mine; both near Pioche, Lincoln County, Nevada.

LINGULELLA ELLSI (Walcott).

Plate XIX, figures 3, 3a–c.

Obolus (*Lingulella*) *ellsi* WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 402. (Described and discussed as below as a new species.)

Shell small, broad ovate in outline, with the ventral valve obtusely acuminate, and the dorsal valve broadly rounded; valves appear to have been moderately convex, judging from their appearance in the siliceous shale. The surface of the shell is marked by rather strong, concentric lines and striæ of growth, the striæ apparently indicating a slightly lamellose surface; very fine radiating striæ occur on the surface of the inner layers of the shell. A ventral valve 3.5 mm. in length has a width of 2.75 mm.; the dorsal valve is a little shorter than the ventral valve.

Partial casts of the interior of the ventral valve show a very clearly defined area that extended as a shelf on each side of the rather deep, narrow, pedicle furrow; portions of the casts that fill the undercut may be observed in several specimens; the flexure lines are narrow, sharp, and situated well out toward the lateral margins. The cast of the visceral area of the ventral valve extends about one-third the distance from the area to the anterior margin; it is not well defined, and no traces of muscle scars have been detected; of the vascular system only the base of the main sinuses is shown in any of the casts.

Observations.—This very pretty little species is closely related in form to *Lingulella rotunda* (Matthew), and comparison should also be made with the more rotund variety of *L. ferruginea* Salter. It occurs in association with *Acrothele pretiosa* (Billings).

The specific name is given in honor of Dr. R. W. Ells, whose fine work on the geology of a portion of the Province of Quebec unraveled the stratigraphic relations of the Lauzon slates in which the species occurs. Doctor Ells guided me to the locality at which the species occurs.

FORMATION AND LOCALITY.—**Ordovician**: (220a) Shales of the "Upper Sillery" (Lauzon of Logan), on Chaudiere River at the Grand Trunk railroad bridge, Province of Quebec, Canada.

LINGULELLA FERRUGINEA Salter.

Plate XXIX, figures 1, 1a–w, 2, 2a–f; Plate XXX, figure 1; Plate XXXI, figures 3, 3a–c; Plate XXXV, figures 4, 4a–b.

Lingulella unguiculus SALTER, 1866, Rept. British Assoc. Adv. Sci. for 1865, p. 285. (Mentioned in a list of fossils from the "Menevian group.")

Lingulella ferruginea SALTER, 1867, Quart. Jour. Geol. Soc. London, vol. 23, pt. 1, p. 340, fig. 1. (Described by Salter as a new species in the paper by Salter and Hicks, see p. 497 for copy. Fig. 1 is reproduced in this monograph, Pl. XXIX, fig. 2b.)

Lingulella ferruginea ovalis HICKS, 1867, idem, p. 341, figs. 2 and 3, p. 340. (Characterized by Hicks as a new variety, and discussed by Salter and Hicks, in the paper by Salter and Hicks. Figs. 2 and 3 are reproduced in this monograph, Pl. XXIX, figs. 2 and 2a, respectively.)

Lingulella ferruginea Salter, DAVIDSON, 1868, Geol. Mag., vol. 5, pp. 306–307, Pl. XV, figs. 1–8. (Described and discussed. Figs. 7a and 6a are reproduced in this monograph, Pl. XXIX, figs. 2c and 2d, respectively.)

Lingulella ferruginea ovalis Hicks, DAVIDSON, 1868, idem, p. 307. (Mentioned in discussion of *L. ferruginea*.)

Lingulella ferruginea Salter, DAVIDSON, 1871, British Fossil Brachiopoda, vol. 3, pt. 7, No. 4, pp. 336–337, Pl. XLIX, figs. 32–35. (Described and discussed, see p. 497 for copy of part of discussion. Figs. 35a and 33a are reproduced in this monograph, Pl. XXIX, figs. 2e and 2f, respectively.)

Lingula or *Lingulella* sp. LINNARSSON, 1876, Bihang till K. svensk. Vet.-Akad. Handl., Bd. 3, No. 12, pp. 15–16, Pl. III, figs. 24–28. (Described and discussed in English. Fig. 28 is reproduced in this monograph, Pl. XXXI, fig. 3c.)

Lingulella sp. undt. LINNARSSON, 1879, Sveriges Geol. Undersökning, Afhandl. och uppsatser, Ser. C, No. 35, p. 25, Pl. III, figs. 38 and 39. (Described in Swedish.)

Lingulella ferruginea Salter, SALTER and ETHERIDGE, 1881, Mem. Geol. Survey Great Britain, vol. 3, 2d ed., p. 538. (Occurrence mentioned.)

Lingulella ferruginea Salter, DAVIDSON, 1883, British Fossil Brachiopoda, vol. 5, pt. 2, Pl. XVII, fig. 35. (No text reference.)

Lingula? dawsoni MATTHEW, 1884, Manuscript name requested by Walcott.

Lingula? dawsoni Matthew, WALCOTT, 1884, Bull. U. S. Geol. Survey No. 10, p. 15, Pl. V, fig. 8. (Described and discussed as a new species, see p. 497 for copy. The specimen represented by fig. 8 is redrawn in this monograph, Pl. XXIX, fig. 1d.)

Lingulella dawsoni MATTHEW (in part), 1886, Trans. Roy. Soc. Canada for 1885, vol. 3, sec. 4, No. 3, pp. 33–34, Pl. V, fig. 9d (not figs. 9, 9a–c). (Described and discussed as a new species, but refers in synonymy to preceding reference. The specimen represented by fig. 9d is redrawn in this monograph, Pl. XXIX, fig. 1. The specimens represented by figs. 9, 9a–c are referred in this monograph to *Lingulella martinensis*.)

Lingulella linguloides MATTHEW, 1886, idem, p. 34, Pl. V, figs. 8, 8a–b. (Described and discussed as a new species. The two specimens represented by figs. 8, 8a–b are redrawn in this monograph, Pl. XXIX, figs 1a, 1b, and 1c, respectively.)

Obolella? gemmula MATTHEW, 1892, Trans. Roy. Soc. Canada for 1891, vol. 9, sec. 4, No. 5, pp. 41–42, Pl. XII, figs. 8a–c. (Described and discussed as a new species. The specimens represented by figs. 8b and 8c are redrawn in this monograph, Pl. XXIX, figs. 1u and 1v, respectively.)

Lingulella dawsoni (Matthew), HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 58, Pl. II, fig. 5. (Mentioned in text. Fig. 5 is drawn from the specimen figured by Matthew, 1886, Pl. V, fig. 9d.)

Lingulella cf. *ferruginea* Salter, KAYSER, 1897, Zeitschr. Deutsch. geol. Gesell., Bd. 49, Heft 2, No. 2, p. 280, Pl. VII, fig. 7. (Characterized and discussed in German. Fig. 7 is reproduced in this monograph, Pl. XXX, fig. 1.)

Obolus (*Lingulella*) *gemmulus* (Matthew), WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 673. (Merely changes generic reference.)

Leptobolus cf. *linguloides* MATTHEW, 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 5, No. 20, p. 407. (Described.)

Leptobolus linguloides MATTHEW, 1902, idem, p. 407. (Merely changes generic reference.)

Lingulella ferruginea Salter, MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 108. (Discussed in description of "*Leptobolus atavus*.")

Leptobolus gemmulus MATTHEW, 1903, idem, pp. 190–192, Pl. XIV, figs. 1a–c. (Original description, Matthew 1892, p. 41, copied, revised, added to, and discussed.)

Leptobolus cf. *linguloides* MATTHEW, 1903, idem, pp. 192–193. (Copy of Matthew, 1902b, p. 407.)

Leptobolus linguloides MATTHEW, idem, p. 193. (Merely changes generic reference.)

The original description by Salter [Salter and Hicks, 1867, p. 340] is as follows:

Length fully 2.5 lines. Form ovate-oblong, the front rather obtuse, but not straight edged; the sides nearly parallel; the obtusely pointed beak includes an angle of about 75°. Generally convex, especially down the median area; the sides beveled obliquely; the surface concentrically and very finely striated; the inner surface rather coarsely sulcate concentrically, indicating close ridges or sharp waves of growth upon the outer surface (not visible in our specimens). The inner surface (and probably the outer) shows radiating lines (rather coarse ones) over the median area, but not on the sides.

The pedicle groove is so wide and pyramidal as to open at an angle of 40°; and its edges are so strongly pronounced as to give the appearance of hinge plates. A short median ridge divides this area, and extends but a very short distance. A specimen, apparently of the shorter valve, has also a median line, but fainter and longer. This is uncertain, the specimen being much crushed.

The foregoing description was followed by a description of a variety named *ovalis* by Hicks [Salter and Hicks, 1867, p. 341]. It was collected in the Red Rocks of the Menevian group near St. Davids, and the varietal name was given to it on account of the front edge being "rounded off, and not squared at all." Davidson [1868, p. 307] stated that he did not consider this character of any importance, as he had before him specimens of *L. ferruginea* of a similar size which had the front quite as much rounded off. Davidson [1868, p. 307] also states that there can be no doubt as to the shell termed *Lingulella unguiculus* by Salter in 1865 being the same species as *L. ferruginea* described in 1867. He also states that it is true that *L. ferruginea*, like most of its congeners, varies slightly in its shape in different examples; some having their front and middle more rounded than others, and the posterior portion conyerging rather more in some individuals than in others.

Davidson [1871, p. 336] further observes that—

this small species has been correctly described and illustrated by Mr. Salter; and is, as far as we are aware, the earliest brachiopod hitherto discovered; for specimens [Davidson, 1871, Pl. XLIX, fig. 35] were found by Hicks at the middle and the very base of the purple and red rocks of Sedgwick's "Harlech group," which directly underlies the "Menevian group" or lowest *Lingula* flags. The position is about 1,200 feet (365.8 m.) lower in the series than the specimen described by Salter and Hicks [1867, p. 340]. The shell does not appear to be scarce, but the beds are much cleaved, and their color is not in any way favorable to the exhibition of the characters of so thin a shell.

In my remarks [1884a, p. 15] upon the species "*Lingula? dawsoni*" Matthew, I called attention to the close resemblance between that species and *Lingulella ferruginea*, and said that with only a specimen of the ventral valve for comparison it was difficult satisfactorily to determine the specific relations of the species.

With the large collections now before me from Newfoundland, and Matthew's and our own specimens from New Brunswick, it is possible to refer the form that has been described as *Lingula? dawsoni* to *Lingulella ferruginea*.

Before making comparisons between the American and Welsh representatives of the species described, I will quote the original description of *L. dawsoni* [Walcott, 1884a, p. 15], and add such additional data as the specimens from the other collections of Newfoundland have afforded:

Shell small, broadly subelliptical, subattenuate toward the beak; the margins gradually expanding and curving from the beak to the center, where the shell has its greatest width, and thence narrowing toward the front, which is broadly rounded. General surface depressed, convex, becoming more convex toward the beak.

Surface marked by fine undulating concentric lines crossed by radiating lines that are seen only by the aid of a strong magnifying glass.

In form this species approaches *Lingulella ferruginea* Salter of the Menevian formation of Wales quite closely, but with only a specimen of the ventral(?) valve to compare with it, it is difficult satisfactorily to determine its specific relations.

From the Newfoundland material the following additional description is taken:

The dorsal valve is ovate and moderately convex as it occurs in the shale.

The shell appears to have been thin, and built up of two or more layers or lamellæ. The surface described for the type specimen is correct for the surface when the thin outer layer is exfoliated. The outer surface, as shown by a small bit of it on the type specimen, is of the

same general character as that of *Lingulella radula* Matthew and *Lingulella martinensis* Matthew. It is exceedingly fine and is discernible only with a strong magnifier.

The surface of a specimen represented by Plate LXIX, figure 1t, is marked, in addition to the radiating and concentric lines, by irregular, more or less transverse lines that suggest the surface of species referred to the subgenus *Westonia*. Associated specimens do not show this peculiarity of surface.

The interior of the dorsal valve is not well shown. In two specimens (Pl. XXIX, figs. 1 and 1 l) traces of the visceral area are preserved, and the area and pedicle groove are indicated in figure 1f. In the casts of the dorsal valve the area is clearly defined (fig. 1n) and the transmedian (i) and the central muscle scars (h) (fig. 1q). The main trunk of the vascular sinus is far out toward the margins (fig. 1r), and in the same interior the paths of advance of the muscle scars are unusually prominent. A median sinus appears to be indicated in figure 1n.

Observations.—Through the courtesy of Dr. Gilbert D. Harris I have been able to compare the type specimen of "*Lingula? dawsoni*," which belongs to the Hartt collection of Cornell University, with the specimens referred to the species by Matthew. Only one of Matthew's specimens [1886, Pl. V, fig. 9d] belongs to the species. Two other specimens, however, described and figured as "*Lingulella linguloides*" [Matthew, 1886, p. 34], are undoubtedly specifically identical with the original type of "*Lingula? dawsoni*," Matthew's identification being based on the figure of the specimen described and illustrated by me [1884a, p. 15].

Two other specimens illustrated by Matthew [1886, Pl. V, figs. 9, 9a–c] as "*Lingulella dawsoni*" appear to be identical with *L. martinensis* Matthew. Both the ventral and dorsal valves of the two figured specimens are broken away at the beak, and allowance is also made for their being compressed in shale, while the types of *L. martinensis* are embedded in sandstone.

It will be noticed that our Plate XXIX, figure 1, differs from Matthew's figure 9d [1886, Pl. V] in the form of the visceral area, although they are drawn from the same specimen. The shell is small, and the markings are somewhat indistinct, but from what may be seen and from our knowledge of the form of the markings in the closely related species, I think the change in the figure is necessary.

A shell that appears to be identical with this species occurs in the compact, gray, thin-bedded sandstones that are interbedded in the Upper Cambrian shales on McNeil Brook, 1.5 miles (0.94 km.) east of Marion Bridge, Cape Breton, Nova Scotia. The species is abundantly represented, the partings of the shaly sandstone often being nearly covered with the detached valves. The average length of the ventral valve is 3 mm.

Lingulella ferruginea occurs in abundance in the shales and interbedded limestones of the Manuels Brook section, Newfoundland, and also in the dark shales above the Lower Cambrian beds near Topsail Head, on the shore of Conception Bay. In order to exhibit the range of variation caused by the character of the embedding matrix, a number of specimens are illustrated. Plate XXIX, figures 1e to 1k, and 1n, are from the shales; figures 1f, 1i, 1j, and 1k show the effect of compression and distortion, while figures 1 l, 1m, 1o, 1p, and 1q, from the limestone, are more convex and regular, although the specimens they represent were chosen as illustrating variation in form.

In the Manuels Brook section, Newfoundland, *Lingulella ferruginea* is associated with *Acrotreta misera, Agnostus punctuosus, Microdiscus punctatus, Paradoxides davidis, P. hicksi, Anopolenus venustus, Conocoryphe elegans, Ctenocephalus matthewi, Erinnys venulosa, Ptychoparia robbi, P. variolaris, Holocephalina inflata, Agraulos socialis*, etc. [Walcott, 1891b, p. 261].

Davidson [1868, p. 306] gives a list of the fossils that occur in association with *Lingulella ferruginea* in the Menevian group of Wales. Among them we find *Paradoxides davidis, P. hicksi, Erinnys venulosa, Ptychoparia variolaris;* also the genera *Holocephalina* and *Anopolenus*.

The above-mentioned association of species in the Newfoundland and Welsh beds shows that *Lingulella ferruginea* occurs in the same relative faunal horizon on the two sides of the Atlantic. A comparison of the illustrations of the type specimens [Salter and Hicks, 1867, figs. 1–3] and those subsequently described and illustrated by Davidson [1871, Pl. XLIX, figs. 33 and 35] shows clearly that there are no true specific differences between the two species.

In order to place these clearly before students, the original figures of Salter [Salter and Hicks, 1867, figs. 1–3] and Davidson [1871, Pl. XLIX, figs. 33 and 35] are reproduced on Plate XXIX.

"*Leptobolus gemmulus*" Matthew [1903, p. 190] appears to be a true *Lingulella* and specifically identical with *L. ferruginea*. It occurs at a higher horizon (Division 3c of Matthew's section) than the typical forms of the latter in Wales and near St. John, New Brunswick, but that is not surprising for a species which has so wide a geographic distribution. Only one specimen from the type locality at Navy Island, St. John, sent to me by Matthew, shows the area and central groove of the ventral valve. In the shales of his Division C3e on McLeod Brook, Cape Breton, Matthew collected a fine series of compressed and flattened shells that he referred to "*Leptobolus gemmulus*." These shells appear to have the broad form as the result of being flattened in the shale. The same changes occur in typical specimens of *L. ferruginea* when flattened in the shales at Andrarum, Sweden. In the interbedded limestones they are narrower and more convex. I note the same differences also in specimens from the shaly sandstones of McNeil Brook, Cape Breton. The narrow, uncompressed forms are shown by Plate XXXV, figures 4, 4a–b. In the same sandy shales occur flattened shells that are as broad as those referred to "*Leptobolus gemmulus*" Matthew [1903, p. 190] (Pl. XXIX, figs. 1u and 1v).

Lingulella lepis Salter, when uncompressed, has the broad form given to *L. ferruginea* by compression, and would be compared with Matthew's "*Leptobolus gemmulus*" if the latter were retained as a species.

A species that appears to be identical with this occurs at Hastings Cove, St. John County, New Brunswick, and a closely allied form, compared by Matthew [1895a, p. 115] with *Lingulella granvillensis*, occurs in the "*Protolenus* beds" of Hanford Brook, St. John County, New Brunswick.

Linnarsson [1876, Pl. III] gives several illustrations of a small *Lingulella* from the *Paradoxides* beds. One of them (see Pl. XXXI, fig. 3c) is an elongate form that may represent a distinct species from the broader forms represented by Plate XXXI, figures 3, 3a, and 3b in this monograph. A direct comparison between specimens from the limestones of Sweden and Newfoundland leads to the conclusion that they belong to the same species.

Kayser [1897, Pl. VII, fig. 7] illustrates a species of *Lingulella* from Iruya, northern Argentina, that he compares with *L. ferruginea* Salter. It certainly resembles that species very closely, and with our present knowledge of the wide distribution of *L. ferruginea*, I believe we are justified in identifying the South American form as the representative of that species. The figure given by Kayser [1897, Pl. VII, fig. 7] is reproduced on Plate XXX. The associated species given by Kayser [1897, pp. 277–281] are *Liostracus ulrichi*, *L. steinmanni*, *L.* sp., *Agnostus iruyensis*, *Lingulella* cf. *davisi*, and *Orthis saltensis*.

Formation and locality.[a]—**Upper Cambrian:** (**3h**) Shale and shaly limestone on McNeil Brook, 1.5 miles (2.4 km.) east of Marion Bridge; (**307** [Matthew, 1903, p. 192]) shales of Division C3c of Matthew, on McLeod Brook (=Barachois River); and (**307a** [Matthew, 1903, p. 240]) shales of Division C3c2 of Matthew, on McLeod Brook (=Barachois River), near Boisdale; all in eastern Cape Breton, Nova Scotia, Canada.

(**308** [Matthew, 1892, p. 41]) Shales of Division C3c of Matthew at Navy Island, St. John Harbor, St. John County, New Brunswick, Canada.

(**3**) Shaly limestones 300 feet (91.4 m.) above the *Paradoxides* zone, Manuels Brook, Conception Bay, Newfoundland.

(**310d**) *Ceratopyge* slate at Borgholm, Oeland Island, Sweden.

(**389d** [Kayser, 1897, p. 280]) Iruya, Province of Salta, Argentina, South America.

Middle Cambrian: (**3i**) Compact, fine-grained, thin-bedded, gray sandstone of the *Paradoxides* zone, on McLean Brook, 1 mile (1.6 km.) east of McCodrum Brook, and 1.5 miles (2.4 km.) west of Marion Bridge, eastern Cape Breton, Nova Scotia, Canada.

(**2s**) Limestone in upper part of *Paradoxides* zone, at Hastings Cove [Matthew, 1898b, p. 38], on Kennebecasis Bay, 0.5 mile (0.8 km.) northeast of Torryburn, on the Intercolonial Railway northeast of St. John; (**2i**) sandstones of Division 1b3 of Matthew's [1895a, p. 108] *Protolenus* zone, on Hanford Brook; and (**2l**) limestone at the base of the *Paradoxides* zone [Matthew, 1895a, p. 108]; all on Hanford Brook, St. John County, New Brunswick.

(**301l**) Shales of Division 1d of Matthew on Porters Brook, St. Martins; (**2m**) shales near the base of the *Paradoxides* zone on Hanford Brook; (**301k**) St. John formation in the city of St. John; (**301h**) shales of Division 1c of Matthew, on Hanford Brook; (**301g**) sandstones of Division 1c of Matthew, at Portland (now a part of the city of St. John); and

[a] This species also occurs at Localities **318u** and **318v**, p. 249.

(301z) in Division Ic of Matthew at Ratcliffs Millstream; all [Matthew, 1886, p. 34] in St. John County, New Brunswick.

(1a, 6l, and 6n) Shales near the top of No. 6 of the Manuels Brook section; (6r and 6u) limestone and shale, respectively, on the west side of Manuels Brook; (1) shales of zone A of No. 7 of the Manuels Brook section; and (2) shales of zone B of No. 7 of the Manuels Brook section; all on Manuels Brook [Walcott, 1891b, p. 261], Conception Bay, Newfoundland.

(2a) Shales from same horizon as No. 1, Topsail Head, Conception Bay, Newfoundland.

(6g) Limestone near the base of the Middle Cambrian, the lowest horizon carrying *Paradoxides*, northwest side of Chapple Arm Harbor, about 1 mile (1.6 km.) from its head, Trinity Bay, Newfoundland.

(318j [*Salter, 1866b, p. 340*]) *Black shales of the Menevian group at Pen-y-pleidiau, St. Davids;* (318h) shales in the Menevian at St. Davids; (318o)[a] red shales at the base of the Harlech grits at Solva; (366b) red shales at the base of the Harlech grits at Porthclais Harbor, south of St. Davids; and (318n)[a] red shales at the base of the Harlech grits at St. Davids; all in South Wales.

(318e)[a] Lower portion of the Menevian at Camlan; (318k)[a] in the Menevian rocks at Tafern Helig; (318l)[a] in the Menevian rocks at the Waterfall Valley, near Maentwrog; all in North Wales.

(8w) Limestones of the *Paradoxides forchhammeri* zone, at Andrarum, 20 miles (32.2 km.) northwest of Simrishamn, Province of Christianstad; (310q) limestone of the *Agnostus lævigatus* zone at Lovened, Province of Skaraborg; (320m [Liunarsson, 1876, p. 15]) limestones of the *Paradoxides forchhammeri* zone at Kinnekulle, Province of Skaraborg; (320n [Liunarsson, 1876, p. 16]) limestones of the *Paradoxides forchhammeri* zone at Lovened, Djupadal, 19 miles (30.6 km.) south-southeast of Skara, Province of Skaraborg; (310m [Linnarsson, 1876, p. 16]) arenaceous shales of the *Paradoxides tessini* zone on Oeland Island; (310o) limestone of the *Paradoxides tessini* zone at Borgholm, Oeland Island; (310p) limestone of the *Paradoxides œlandicus* zone at Borgholm, Oeland Island; (310y) limestone at Kiviks Esperöd, Province of Malmöhus; and (310z) limestone at Brantevik, on the shore a little south of Simrishamn, Province of Christianstad; all in Sweden.

(16h) Limestones of the *Paradoxides forchhammeri* zone at Borregaard; and (16j) limestones of the *Paradoxides forchhammeri* zone at Laesaâ; both on Bornholm Island, Denmark.

(324d) Windjuelandet, Ringsaker, Province of Hedemarken, Norway.

This species is somewhat doubtfully identified from the following localities:

Upper Cambrian: (6s) Just north of Fosters Point, Random Island, Random Sound, Newfoundland.

Middle Cambrian: (1) Shales of zone A of No. 7 of the Manuels Brook section [Walcott, 1891b, p. 261], Manuels Brook, a small stream which flows into Conception Bay from the east, near Topsail Head, Newfoundland.

(2i) Sandstones of Division 1b3 of Matthew's [1895a, p. 108] *Protolenus* zone, Hanford Brook, St. John County, New Brunswick.

Lingulella cf. ferruginea.

Plate XXX, figure 4.

Lingulella (?) sp. Pompeckj, 1896, Jahrb. K.-k. geol. Reichsanstalt, Bd. 45, Hft. 3, p. 509, Pl. XIV, figs. 16a–b. (Described in German; see below for translation. Figs. 16a–b are reproduced in this monograph, Pl. XXX, fig. 4.)

The original description by Pompeckj is as follows:

There is on hand a ventral valve which, owing to its bad state of preservation, can not be assigned to the genus *Lingulella* otherwise than doubtfully.

Outline elongated, pentagonal with corners rounded off. The length is somewhat more than double the breadth. The vertex (beak?) is drawn far forward. The surface shows a concentric striation. In front of the vertex (beak?) is seen a short median groove.

The form recalls *Lingulella* (?) sp. undt., which Linnarsson [1876, p. 15] described from Kinnekulle; but it is more slender than the species made known from the *Paradoxides* slate of Sweden.

This little shell is probably the representative of *Lingulella ferruginea* Salter of the English and Swedish *Paradoxides* fauna.

Formation and locality.—**Middle Cambrian:** (345 [Pompeckj, 1896b, p. 509]) Greenish shales in the *Paradoxides* zone on the Dlouhá Hora, above the brook of Sbirov, near Skrej, Bohemia, Austria-Hungary.

Lingulella flumenis (Matthew).

Plate XXXV, figures 6, 6a–b.

Leptobolus flumenis Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 189–190, Pl. XI, figs. 7a–f. (Described and discussed as a new species; see p. 501 for copy. The specimens represented by figs. 7a, 7b, and 7e are redrawn in this monograph, Pl. XXXV, figs. 6, 6a–b, respectively.)

[a] Davidson, 1871, p. 337.

The original description by Matthew is as follows:

A narrowly ovate species, somewhat straight on the sides, and broadly rounded in front.

The ventral valve has an obtusely pointed beak, bent down at the apex. Sides of the valve somewhat sharply sloped in the posterior half and gently sloped in front. *Interior.*—This shows an area nearly half a millimeter long, and a visceral callus extending about half the length of the valve. The lateral ridges within the valve extend as far; and in front of them, reaching to within a sixth of the length of the valve from the front, is a pair of arched vascular grooves not far from the margin of the valve; numerous external branches from these trunk grooves extend to the flattened margin of the valve. The individual length of these branches is about equal to the width of the main groove.

The dorsal valve is obtusely rounded at the hinge area, which is very short, and here and at the sides the valve is strongly arched downward, but is gently sloped down in front. *Interior.*—In front of the linear cardinal area is a pair of pits marking the insertion of the cardinal muscles. The middle of the valve for more than half the valve's length has a flattened band marking the progress of the central muscles during the growth of the shell. At the front this band is about one-sixth or one-eighth of the width of the valve, and at its sides are faint prints of the central muscles; and at the front are two pairs of minute pits, one or both of which marks the position of the anterior laterals. The place of the posterior laterals is marked by a series of small pits near the margins in the posterior third of the valve. In front of these pits are the strong arched grooves left by the vascular trunks, which extend across the middle half of the valve near its margins.

No examples have been obtained showing the surface markings, except those near the front of the valve; but both valves show from four to six ridges of growth in the anterior quarter of the valve. These ridges are broadly curved in the middle part, but more abruptly at the sides.

Ventral valve 4 mm. long and 2.5 mm. wide. The dorsal valve is nearly one-half millimeter shorter than the ventral.

This species is of nearly the same size as *L. insulæ*, but is less elliptical in outline, and the valves are more flattened in front; the area of the ventral valve also is longer, and that of the dorsal shorter than in that species; also the central group of muscles is not set so far forward as in that of the dorsal of the species cited.

This species differs from *L. atavus* of the Etcheminian terrane in having the central muscles of both valves set farther back.

The exact horizon of this species is uncertain, as the outcrop is in an isolated basin [Matthew, 1903, p. 51]. Matthew correlated it with his section on the lithologic character of the matrix. The form is very much like that of *Lingulella collicia* (Matthew), and it appears to be identical with small shells of the latter species.

Formation and locality.—**Middle Cambrian:** (325a [Matthew, 1903, p. 190]) Shales of Division C2c of Matthew's [1903, p. 49] Bretonian on the eastern slope of the valley of McNeil Brook, on the road to Trout Brook, in the Mira River valley, eastern Cape Breton, Nova Scotia.

Lingulella franklinensis (Walcott).

Plate XXVI, figures 3, 3a–b.

Obolus (*Lingulella*) *franklinensis* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 404–405. (Described and discussed essentially as below as a new species.)

Shell small, ovate, moderately convex, with the apex of the dorsal valve subacuminate. Surface of the shell marked by rather strong lines and striæ of growth, with very fine, slightly irregular, wavy striæ between the coarser concentric striæ. Two ventral valves referred to this species have a length of 3 and 3.5 mm., respectively, with a width of about 2.75 mm. There are no dorsal valves in the collection. A partial cast of the interior of the shell carries an impression of radiating striæ, a strong cast of a narrow pedicle furrow, and a few concentric lines of growth. If the shell represented by Plate XXVI, figure 3b, belongs to this species, the interior surface was also marked by scattered bits of punctæ.

Observations.—This species is founded on three specimens of the ventral valve that occur in the limestones interbedded in dark shales above the Lower Cambrian *Olenellus*-bearing shales. A larger shell (Pl. XXVI, fig. 3b) has the same surface characters and occurs at the same relative geological horizon, and it may belong to this species; the only specimen of it in the collection is apparently a dorsal valve. The exact stratigraphic horizon has not been determined, but from the associated species of *Agnostus* and *Ptychoparia* it appears that the reference should be to the Middle Cambrian.

The material for study is so limited that it is difficult to make comparisons with other species. In form the ventral valve resembles that of *Lingulella lineolata* (Walcott) (Pl. XLVIII), *L. tarpa* (Walcott) (Pl. XXIII), and in some respects *L. granvillensis* Walcott (Pl. XXII), with which it would be more naturally compared owing to its belonging to the Appalachian fauna.

The specific name is derived from Franklin County, Vermont, in which the species occurs.

FORMATION AND LOCALITY.—**Middle Cambrian:** (28a) "St. Albans formation," in limestone lentil about 1 mile (1.6 km.) east of Parker's quarry, west of Georgia; (319v) sandy shale, 2 miles (3.2 km.) east of Highgate Springs; and (87) *conglomerate limestone 1 mile (1.6 km.) south-southwest of Highgate Falls;* all in Franklin County, Vermont.

LINGULELLA FUCHSI Redlich.

Plate XXXIX, figures 2, 2a–c, 3.

Lingulella fuchsi REDLICH, 1899, Mem. Geol. Survey India, Paleontologia Indica, new ser., vol. 1, No. 1, Cambrian Fauna of the Eastern Salt Range, p. 7, Pl. I, figs. 10a–e. (Described and discussed as a new species. Fig. 10c is reproduced in this monograph, Pl. XXXIX, fig. 3.)

Obolus (*Lingulella*) *fuchsi* (Redlich), WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 332. (Discussed somewhat as below.)

In the collection of fossils received from Doctor Noetling I find, associated with *Lingulella wanniecki* Redlich, a small elongate form that appears to be identical with *L. fuchsi* of Redlich. Redlich states [1899, p. 10] that his *L. fuchsi* occurs in a hard clay above the lower magnesian sandstones which rest on the shales containing *L. wanniecki*. If my identification of the species is correct, *L. wanniecki* has a greater vertical range, or there may have been some error in the identification and labeling of the zone from which the original specimens were obtained. The identification of the species in the material before me is based on the form of the ventral valve, as shown by Redlich's figure 10c [1899, Pl. I] and my figure 2 (Pl. XXXIX). The dorsal valves represented by Plate XXXIX, figures 2a–c, differ materially from Redlich's illustration; but in the specimen represented by figure 2d the little pit mentioned by Redlich [1899, p. 7] is shown, also two ridges that leave a concave furrow in the central portion of the cast of the valve. These are the lines of the main vascular sinuses.

FORMATION AND LOCALITY.—**Middle Cambrian:** (15r)[a] Dark argillaceous shale, at Khussak, Salt Range, India.

LINGULELLA GRANDIS (Matthew).

Plate XXXVIII, figures 2, 2a–f.

Leptobolus grandis MATTHEW, 1894, Trans. Roy. Soc. Canada for 1894, 1st ser., vol. 11, sec. 4, No. 8, pp. 91–92, Pl. XVI, figs. 7a–c. (Described and discussed as a new species. The specimens represented by figs. 7a and 7b are redrawn in this monograph, Pl. XXXVIII, figs. 2b and 2f, respectively.)

Lingulella? cuneata MATTHEW, 1894, idem, pp. 92–93, Pl. XVI, figs. 5a–b. (Described and discussed as a new species. Matthew's types of *Lingulella cuneata* are figured in this monograph, Pl. XXXVIII, figs. 2, 2a, 2c, and 2d, but it is impossible to tell which of these Matthew figured, Pl. XVI, figs. 5a–b.)

Lingula cf. *billingsiana* Whiteaves, MATTHEW, 1894, idem, p. 93, Pl. XVI, figs. 6a–b. (Described and discussed.)

Lingulella? billingsana SCHUCHERT (in part) [not (WHITEAVES)], 1897, Bull. U. S. Geol. Survey No. 87, p. 256. (Merely changes generic reference of Matthew's species *Lingula* cf. *billingsiana* cited above.)

Not *Leptobolus* cf. *grandis* MATTHEW, 1902, Trans. Roy. Soc. Canada for 1902, 2d ser., vol. 8, sec. 4, No. 3, p. 111. (Characterized. This species is given by Matthew as occurring on Mount Stephen, British Columbia. For the species occurring at this locality see pp. 127–128.)

General form subcuneate, with the ventral valve acuminate and the dorsal valve elongate-ovate; valves more than usually convex for a species of the genus. Surface of shell marked by concentric striæ and strong lines of growth, and, where the outer surface is perfect, by almost microscopic, irregular, semi-inosculating, elevated striæ, that under a high power give the surface an appearance somewhat similar to that of *Lingulella* (*Lingulepis*) *roberti* (Matthew) and *Obolus* (*Westonia*) *ella* (Hall and Whitfield) (Pl. XLVII). In almost every instance this surface adheres to the matrix, leaving the glossy inner surface described by Matthew [1894, p. 92]; the inner layers or lamellæ are marked by numerous fine radiating striæ and concentric growth lines;

[a] Specimens from the type locality were given to the United States National Museum and this number was assigned to them.

a few large punctæ were seen on the interior of one ventral valve. The shell is unusually thick for its size. It has a thin outer layer and several inner layers or lamellæ that are arranged very much as in *Lingulella acutangula* (Roemer) (Pl. XVII).

A relatively large ventral valve has a length of 7 mm. and a width of about 5.5 mm.

The cast of the area of the ventral valve shows a long area divided midway by a narrow pedicle groove, and toward the lateral margins by a very narrow flexure line. The area of the dorsal valve is shorter in proportion than that of the ventral valve, and also less extended on the cardinal slopes. The cast of the visceral cavity (v), including the outline of the heart-shaped cavity (x), is very well shown by Plate XXXVIII, figures 2a and 2b. There are no traces of a median septum in the ventral valve, but in the dorsal valve it is a very narrow sharp crest on the summit of the broad, strong, median ridge that extends from the area fully three-fourths of the distance to the front margin; the septum appears to be confined to the anterior half of the length of the ridge.

The muscle scars are not clearly defined in either valve. The trapezoidal areas of the ventral valve, where the central scars and the middle and outside laterals are usually located, are present, but the individual scars can not be differentiated. In the dorsal valve the central scars appear to be unusually large; they are situated on each side of the broad median ridge, and crowd the parietal scar out to the main vascular sinus; the anterior laterals are situated on each side of the median septum, as shown in Plate XXXVIII, figure 2d, but they are not well defined.

The main vascular sinuses of the ventral valve extend far forward and curve inward so that they appear nearly to unite a short distance back of the anterior margin of the shell; their interior lateral branches appear to touch, and thus give the appearance of uniting the two main sinuses; the lateral branches extend outward from the main sinus nearly to the edge of the shell, while the interior lateral branches are crowded into the space between the main vascular sinuses and the visceral area. The main vascular sinuses of the dorsal valve extend well forward and curve inward toward the median line; their interior lateral branches fill the narrow space between the vascular cavity and the main sinuses; no traces have been observed of the peripheral branches of the vascular system of the dorsal valve. The parietal scar is shown more clearly for the dorsal than for the ventral valve. In the former it extends about the space occupied by the central scars, but it has not been traced outside of the main sinuses or in front of the anterior lateral muscle scars.

Observations.—I was greatly puzzled when studying Matthew's figures [1894, Pl. XVI] of "*Leptobolus grandis, Lingulella? cuneata,* and *Lingula* cf. *billingsiana.*" It seemed, after extended study of the character and variation of the interior markings of *Obolus* and *Lingulella,* that the three species should be referred to *Lingulella* and perhaps to one species. Doctor Matthew very kindly sent me his material, including the type specimens of this species. At first I was inclined to consider "*Leptobolus grandis*" as distinct from *Lingulella,* but on close study it became more and more evident that the differences were such that a generic distinction could not be based upon them. The anterior extension of the main vascular sinuses varies both in form and degree with different species of *Lingulella.* This may be seen by comparing *Lingulella ampla* (Owen), *Lingulella acutangula* (Roemer), etc. The position and size of the visceral area and muscle scars of the dorsal valve are also subject to great variation, as may be seen by comparing *Lingulella acutangula,* and *L. ampla.*

All of the material of Matthew's "*Leptobolus grandis, Lingulella? cuneata,* and *Lingula* cf. *billingsiana*" is from one locality and bed. It comprises a large number of shells on some twenty-seven pieces of rock. I found that there was more or less distortion of the shells by both vertical and lateral compression. Where the interior markings are well preserved the shells can be at once referred to *Lingulella grandis.* It is only in shells that are distorted or a little larger, or where the interior is imperfectly shown, that any doubt arises, and even in this case no undoubted dorsal valve was found that could be referred to any other species than *L. grandis.*

The illustrations of "*Lingulella? cuneata*" [figs. 5a and 5b] and "*Lingula* cf. *billingsiana*" [figs. 6a and 6b] by Matthew [1894, Pl. XVI] are all of ventral valves, and the figures of "*Leptobolus*

grandis" [figs. 7a and 7b] are so diagrammatic that it is impossible to make comparisons between them and the drawings of the same specimens which accompany this monograph.

FORMATION AND LOCALITY.—**Lower Ordovician:** (301s) Gray sandstones of Division 3e(?) of Matthew [1894, p. 91] at McAphee's corner, Hardingville, St. John County, New Brunswick.

LINGULELLA GRANVILLENSIS Walcott.

Plate XXII, figures 1, 1a–d.

Lingulella granvillensis WALCOTT, 1887, Am. Jour. Sci., 3d ser., vol. 34, pp. 188–189, Pl. I, figs. 15, 15a–c. (Described and discussed as a new species. The specimens represented by figs. 15, 15a, and 15b are redrawn in this monograph, Pl. XXII, figs. 1c, 1d, and 1, respectively.)

Lingulella granvillensis Walcott, OEHLERT, 1889, Annuaire géologique universel for 1888, tome 5, p. 1138. (Described in French in a review of the preceding reference.)

Lingulella granvillensis WALCOTT, 1891, Tenth Ann. Rept. U. S. Geol. Survey, pp. 607–608, Pl. LXVII, figs. 4, 4a–d. (Description and figs. 4, 4a–c, copied from Walcott, 1887, p. 188, Pl. I, figs. 15, 15a–c.)

Lingulella granvillensis Walcott, HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 58. (Discussed.)

General form rather broadly ovate, with the ventral valve obtusely acuminate and the dorsal valve obtusely oval. Valves moderately convex, the dorsal being somewhat more so than the ventral. Surface of shell marked by concentric lines of growth, with very fine, slightly undulating striæ between them, and a few very indistinct radiating striæ. The character of the surface of the inner layers and of the interior of the shell is unknown. The shell appears to have been rather thin and formed of a thin outer layer and one or more inner layers or lamellæ.

A rather large ventral valve has a length of 6 mm. and a width of 4.5 mm., and an associated dorsal valve 5 mm. in length has a width of 3.5 mm. The interior of a small ventral valve shows the visceral area and the two main vascular sinuses; on a cast of the dorsal valve the main vascular sinuses are shown, also a fine irregular network of interior branches of the main sinuses and a few peripheral branches of the vascular system. These are shown by Plate XXII, figure 1d. A broad, low ridge, represented on the cast by a shallow depression, extends forward in front of the area two-thirds the distance toward the frontal margin. It is marked on the median line near the center of the shell by a sharp, narrow median septum, and lines indicating the path of advance of the central and anterior lateral muscle scars. The scars are not clearly defined, but appear to be situated as indicated on figure 1d. In front of the anterior lateral muscle scars there is a peculiar rhomboidal area that is not so well defined in any other species.

Observations.—This is one of the small species that in size and general form resembles *Lingulella ferruginea* Salter of the Middle Cambrian of the Atlantic basin; also *L. manticula* (White) of the Upper Cambrian and Lower Ordovician of the Rocky Mountain region; it differs from the former in its broader anterior outline and from the latter in its more acuminate form and shorter area.

This form owes its specific name to the occurrence of the type specimen near Granville, New York.

FORMATION AND LOCALITY.—**Lower Cambrian:** (20a) Gray limestone, interbedded with shaly slates, in a lane west of Lafayette Stevens's house, about 100 yards (91.4 m.) from the main road, in the southern part of Whitehall Township, Fort Ann quadrangle (U. S. Geol. Survey); (21a) limestone below the first fall of Mettawee River, above the North Granville bridge, Fort Ann quadrangle (U. S. Geol. Survey); (37b) limestones 0.25 mile (0.4 km.) east of Salem, Cambridge quadrangle (U. S. Geol. Survey); (38a) *limestone 2 miles (3.2 km.) south of North Granville, on the first road which turns south from the road running between that village and Truthville, 4 miles (6.4 km.) west-northwest of Granville, Fort Ann quadrangle (U. S. Geol. Survey)*; (34) limestone on roadside a little west of the bridge over Poultney River, at Low Hampton, about 5 miles (8 km.) east-northeast of Whitehall, Whitehall quadrangle (U. S. Geol. Survey); (338m) limestone on the roadside north of schoolhouse No. 4, in the northeast part of Whitehall, Whitehall quadrangle (U. S. Geol. Survey); (35) limestone 1.5 miles (2.4 km.) north of Bald Mountain, and 3.5 miles (5.6 km.) north-northwest of Greenwich, Schuylerville quadrangle (U. S. Geol. Survey); (38) limestone 0.25 mile (0.4 km.) north of John Hulett's farmhouse about 3 miles (4.8 km.) west of South Granville, and 4.5 miles (7.2 km.) southwest of Granville, Fort Ann quadrangle (U. S. Geol. Survey); and (338 l) limestone in

the northern part of Easton Station, 3 miles (4.8 km.) south of Greenwich, Cambridge quadrangle (U. S. Geol. Survey); all in Washington County, New York.

(29) Limestone just above the bridge at the Stockport paper mill, on Kinderhook Creek; and (44b) limestone near North Chatham in the northern part of the Kinderhook quadrangle (U. S. Geol. Survey): both in Columbia County, New York.

(25a) Limestone on the Hall (Donaldson's) farm, 2 miles (3.2 km.) east of Swanton, Franklin County, Vermont.

Lingulella hayesi (Walcott).

Plate XXV, figures 1, 1a–j.

Obolus (*Lingulella*) *hayesi* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 405–406. (Described and discussed as a new species, essentially as below.)

Shell small; general form broad ovate, with the ventral valve obtusely acuminate and the dorsal valve rounded ovate; valves moderately convex. Outer surface as seen in casts marked by fine, concentric lines and striæ of growth; the inner surface had fine, radiating striæ and scattered pits or punctæ. The shell appears from the casts to have been of medium thickness and built up of several layers or lamellæ.

The average length of the ventral valve is about 3.5 mm.; width about 3 mm. The dorsal valves are a little shorter than the ventral valves, the length and width being about the same, although some of the shells are a little wider than long.

The casts of the interior of the ventral valve show a clearly defined, strong area, divided midway by the cast of a narrow pedicle groove, and again by sharp flexure lines situated a little nearer the pedicle groove than to the lateral margins. The striæ of growth cross the area parallel with its base, arching over the cast of the pedicle furrow. The area formed a thin shelf between the pedicle groove and the lateral margins, the undercut extending back under the area as shown in the cast by a thin projection of the embedding rock over the area. The area of the dorsal valve is of medium length and marked by striæ of growth and rather clearly defined flexure lines.

The cast of a ventral valve shows the visceral cavity and rather strong and long main vascular sinuses. In the dorsal valve the main vascular sinuses are frequently outlined very beautifully on the siliceous casts; the visceral area surrounded by the parietal band is clearly defined, also the central and anterior lateral muscle scars, and in one cast the transmedian muscle scars.

Observations.—This very pretty species occurs quite abundantly on the siliceous nodules embedded in the Conasauga ("Coosa") shale. It resembles in form *Obolus lamborni* (Meek) and *Obolus willisi* (Walcott), but is a much smaller species. The elongate visceral cavity of the dorsal valve is also of the same type as that of those species. The thickening in front of the visceral cavity (Pl. XXV, fig. 1b) is similar to that which occurs in *Obolus matinalis* (Hall) (Pl. V, fig. 1d). In this character and in its broadly ovate form it comes very close to the forms which are referred to *Obolus*.

The specific name was given in honor of Dr. C. W. Hayes, at that time chief geologist of the United States Geological Survey.

Formation and locality.—**Middle Cambrian**: (90x and 94a)[a] In and attached to the outer surface of siliceous nodules in the Conasauga ("Coosa") shale, Coosa Valley, east of Center, Cherokee County, Alabama.

Lingulella heberti Barrois.

Plate XXXIX, figures 11, 11a–c.

Lingulella heberti Barrois, 1882, Mém. Soc. géol. du Nord, vol. 2, pp. 185–186, Pl. IV, figs. 3a–d. (Described and discussed in French as a new species; see below for translation. Figs. 3a–d are reproduced in this monograph, Pl. XXXIX, figs. 11, 11a–c, respectively.)

The original description by Barrois follows:

Shell corneous, regular, elongated, slightly convex, scarcely inequivalve. Enlarged in the pallial region where the outline is rounded; pointed at the beaks; longer than wide. Marked with well-developed concentric lines of

[a] 90x is the type locality.

growth, some of which are stronger than others. The shell is covered with small fine tubercles, in lines, like certain species of *Kingena* from the Cretaceous, and produced by the fine, oblique, granular striæ. (Pl. XXXIX, fig. 11c.)[a]

The internal molds (Pl. XXXIX, fig. 11b)[a] show clearly that the beaks were provided with a strong pedicle furrow much like that of *Lingulella davisi*, to which these shells have considerable resemblance. The median septum is well marked, likewise the depressions corresponding to the point of attachment of the muscles of the pedicle (Pl. XXXIX, fig. 11b),[a] and also the transmedian muscles.

Observations: The *Lingulella heberti* is clearly related to *Lingula attenuata* Sowerby from the Llandeilo flags. It is distinguished by the ornamentation of the shell, which recalls that of *Lingulella granulata* (Phillips). It should also be compared with the form figured by Linnarsson [1876, Pl. III, figs. 24–30] under the name of *Lingulella? nathorsti*, from the *Paradoxides forchhammeri* beds of Sweden. The latter is perhaps a little longer, but has a very great resemblance to our shell. Mr. Davidson, who has kindly communicated to me the results of his examination of this small shell, so abundant at the base of the Silurian sandstones of Cape Vidio, agrees with us in referring it to the genus *Lingulella;* he believes that despite its resemblance to *Lingulella davisi* and *L. granulata*, it would probably rank as a new species. It is dedicated to M. Hebert, to whom we owe so many discoveries in Pyrenean geology.

Dimensions: Length, 8 to 10 mm.; breadth, 7 to 9 mm.

Formation and locality.—**Ordovician**: (**350a**) *Sandstones of the stage of Cabo Busto, in the cliffs of Cape Vidio, Province of Oviedo;* and (**350b**) sandstones of the stage of Cabo Busto, at Los Negros; both [Barrois, 1882, p. 186] in northeastern Spain.

Lingulella helena (Walcott).

Plate XXIV, figures 3, 3a–d.

Obolus (*Lingulella*) *helena* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 406. (Described and discussed essentially as below as a new species.)

General form ovate, with the ventral valve obtusely acuminate, and the dorsal valve rounded ovate. Valves moderately convex, as far as can be determined from their condition of preservation in the shales. Surface of shell marked by rather strong lines of growth, and very fine irregular, radiating, concentric striæ that appear to inosculate, the surface having something of the appearance of *Obolus* (*Westonia*) *ella* (Hall and Whitfield). The character of the surface markings of the inner layers and the interior of the shell is unknown. So far as can be determined the shell is rather thin, and formed of a thin outer layer and one or more thin inner layers or lamellæ. A ventral valve 8 mm. in length has a width of 6 mm.; another 7.5 mm. in length has a width of 6 mm. An associated dorsal valve 7 mm. in length has a width of 5 mm. These variations in outline are to a considerable extent due to distortion.

As shown in the cast of the interior of the shell, the area of the ventral valve is rather long, and marked midway by a strongly defined cast of a pedicle groove, and midway between that and the outer margin by a very distinct flexure line. The area of the dorsal valve is rather long and quite distinctly marked on a cast of the interior. The cast of the interior of the ventral valve shows a strong main vascular sinus (vs) on each side of the visceral area, and in a cast of the dorsal valve a slight median septum is indicated, also traces of the main vascular sinuses. The only traces of the muscle scars observed are the anterior laterals (j) and a suggestion of the central scars in the dorsal valve.

Observations.—This species is associated with *Obolus* (*Westonia*) *ella* (Hall and Whitfield) in the siliceous shales near Helena, Montana, and what may be a similar form (Pl. XXIV, fig. 3d) occurs with the same species in Big Cottonwood Canyon, Utah, although the latter is quite closely related to *Obolus mcconnelli* (Walcott). In form and surface characters it belongs to the group of which *Obolus* (*Westonia*) *ella* may be taken as a type. It differs from *O.* (*W.*) *ella* in being narrower anteriorly and in its more acute beak.

The specific name is derived from Helena, Montana, near which the type specimen was collected.

Formation and locality.—**Middle Cambrian**: (**30a**) Shale on the north side of Big Cottonwood Canyon, 1 mile (1.6 km.) below Argenta, Wasatch Range, southeast of Salt Lake City, Salt Lake County, Utah.

(**54s**) Dark blue-gray Langston limestone [Walcott, 1908f, p. 198], just above the Cambrian quartzitic sandstones, north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

(**4n**) Limestone about 325 feet (99.1 m.) above the unconformable base of the Cambrian in divide at the head of Jackson Creek (locally known as Sheep Creek), a creek flowing into Jackson Lake about 0.5 mile (0.8 km.) south of its northwestern corner, Teton Mountains, Grand Teton quadrangle (U. S. Geol. Survey), Uinta County, Wyoming.

[a] Barrois's figures are copied in this monograph, and these references are to the figures which correspond with those mentioned by him.

(302s) *Dark siliceo. s shale in a quarry in Last Chance Gulch, south slope of Mount Helena, 1.5 miles (2.4 km.) south of Helena;* and (4u) shales in the Gallatin formation of Peale [1893, Pl. IV], northwest side of canyon, 0.5 mile (0.8 km.) south of Helena; both in Lewis and Clark County, Montana.

Lingulella? humillima (Barrande

Plate XXX, figure 12.

Lingula humillima Barrande, 1868, Faune silurienne des environs de Hof, en Bavière, p. 101, fig. 70. (Characterized in French as a new species. Fig. 70 is reproduced in this monograph, Pl. XXX, fig. 12.)

Lingula humillima Barrande, 1868, Neues Jahrb. für Mineralogie for 1868, p. 691, unnumbered plate, fig. 70. (Copy of preceding reference.)

This species was described from a single small, oval, compressed shell. The author states that its appearance does not permit its identification with any other described species. The shell has a length of 5 mm.; width, 3.5 mm.

Formation and locality.—Passage beds between the Upper Cambrian and the Ordovician: (303c [*Barrande, 1868a, p. 101*]) *Suburbs of Hof;* and (303f [Pompeckj, 1896a, pp. 7 and 8]) railway cut near Schellenberg, a little distance back of the railway station at Neuhof, near Hof; both in Bavaria, Germany.

Lingulella ino (Walcott).

Plate XXVI, figures 4, 4a–b.

Obolus (*Lingulella*) *ino* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 406–407. (Described and discussed essentially as below as a new species.)

Shell a little smaller than the average of the species of the genus. General form ovate, with the ventral valve subacuminate and the dorsal valve ovate in outline. There is some range of variation in the outline of the valves, but as a whole they do not vary more than the difference shown in the ventral valve by Plate XXVI, figures 4, 4a. The convexity of the valves is fairly strong, as the shells are preserved in the somewhat shaly sandstones. Ventral valves 7 mm. in length have a width of from 5.5 to 6 mm.; a dorsal valve 5 mm. in width has a length of 5.25 mm.

As far as may be determined from the casts, the outer surface is marked by concentric lines and striæ of growth, and the inner surface by radiating striæ and concentric lines of growth and scattered pits or punctæ. The shell appears to have been rather thick, and built up of a thin outer layer and numerous lamellæ that over the anterior two-thirds of the shell were oblique to the outer layer; the edges of the lamellæ show very plainly when the outer layer is removed.

The area of the ventral valve as shown by casts of the interior is of medium length, divided midway by a narrow elevated cast of the pedicle furrow, and again by a narrow flexure line about halfway between the pedicle groove and the lateral margin; striæ of growth cross it parallel with the base. The area of the dorsal valve is relatively long, with the flexure lines clearly defined. The interior markings shown in the cast of the ventral valve are the main vascular sinuses and the outline of the visceral area; in the dorsal valve only traces of the visceral area and main vascular sinuses have been observed.

Observations.—This species appears to be more nearly related to *Lingulella tarpa* (Walcott) than to any other of the Middle Cambrian forms. It is a smaller shell than *L. tarpa*, and less acuminate. It has the outline of some of the species of the Atlantic basin fauna such as *Lingulella radula* Matthew (Pl. XLV), but it does not appear to be specifically identical with any of them.

Formation and locality.—**Middle Cambrian:** (13) Sandstones of the Rome formation, 1.5 miles (2.4 km.) east of Post Oak Springs [Hayes, 1894, areal geology sheet], Roane County; (13b) *sandstones of the Rome formation, northeast of Rhea Springs* [*Hayes, 1894, areal geology sheet*], *Rhea County;* and (11) sandstones and shales of the Rome formation, about 1 mile (1.6 km.) east of Post Oak Springs [Hayes, 1894, areal geology sheet], Roane County; all in Tennessee.

(13c) Sandstones of the Rome formation, west side of the sandstone ridge about 2.5 miles (4 km.) southwest of Rome [Hayes, 1902, historical geology sheet], Floyd County, Georgia.

Lingulella? insons (Barrande).

Plate XXXII, figures 2, 2a–e.

Lingula insons Barrande, 1879, Systême silurien du centre de la Bohême, vol. 5, Pl. CV, figs. x: 1–6. (Not described, but figured as a new species. Pl. CV, figs. x: 4A, 3A, 5A, 6A, 6E, and 1f are copied in this monograph, Pl. XXXII, figs. 2, 2a–e, respectively.)

This is one of the forms that, in the character of the area of the ventral valve, suggests both *Lingulella* and *Lingula*. It is introduced more to call the attention of students to the type than as a representative of the genus *Lingulella*. It is possible that it may belong to the subgenus *Leptembolon* of Mickwitz.

Formation and locality.—**Lower Ordovician:** (**303d**) Étage d1, at Swarow; and (**303e**) *Étage d1 at Sta. Benigna;* both [Barrande, 1879b, Pl. CV] in Bohemia, Austria-Hungary.

Lingulella iole (Billings).

Plate XXVII, figures 5, 5a.

Lingula iole Billings, 1865, Geol. Survey Canada, Paleozoic Fossils, vol. 1, p. 215, figs. 199a–e. (Described as a new species. The two specimens represented by figs. 199a–e are redrawn in this monograph, Pl. XXVII, figs. 5 and 5a.)

The type specimens of this species sent to me by Prof. J. F. Whiteaves included single specimens of the ventral and dorsal valves showing only the outer surface, and, where that is exfoliated, the surface of the inner layers or lamellæ. The surface is marked by very fine concentric striæ and lines of growth and very fine, obscure, radiating striæ upon the outer surface which are slightly more marked on the inner layers. The edges of the lamellæ indicate that the shell was of moderate thickness, less so than that of *Obolus cyane* (Billings). The ventral valve has a length of 7.5 mm.; width, 5 mm.; the dorsal valve is 6 mm. in length and 4.5 mm. in width.

This species is associated with *Obolus cyane* and belongs to the same group of species, so far as can be judged from the external form and appearance of the shell.

The stratigraphic horizon appears to correspond with the upper portion of the Chazy and base of the Trenton, of the New York section.

Formation and locality.—**Lower Ordovician:** (**314d**) Limestone of Division P [Billings, 1865a, p. 215] of the "Quebec group," 4 miles (6.4 km.) northeast of Portland Creek, Newfoundland.

Lingulella irene (Billings).

Plate XXVII, figures 6, 6a.

Lingula irene Billings, 1862, Geol. Survey Canada, Paleozoic Fossils, vol. 1, pp. 71–72, figs. 64a–b. (Described as a new species. The specimens represented by figs. 64a–b are redrawn in this monograph, Pl. XXVII, figs. 6a and 6, respectively.)

Lingula irene Billings, 1863, Geol. Survey Canada, Fifteenth Rept. Progress, p. 230, figs. 240a–b. (No text reference. Figures copied from previous reference.)

Lingulella irene (Billings), Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 257. (Merely changes generic reference.)

General form subovate; broadly rounded in front with the ventral valve subacuminate and the dorsal valve rounded at the beak. Surface of shell marked by concentric lines and striæ of growth and fine radiating striæ. The specimens are almost flattened in the shale and the substance of the shell has been very largely removed, so that it is impossible to determine the markings upon the surface, the layers of which it may have been formed, or its thickness. A thickened rim on the ventral valve indicates that the shell was strong and probably built up as in other species of *Lingulella*. The type specimen, the ventral valve, as compressed in the shale, has a length of 16.5 mm., with a maximum width of 13.25 mm. The dorsal valve is 15.5 mm. in length and 14 mm. in width.

The area of the ventral valve is strongly marked and relatively long. It is divided midway by a clearly defined pedicle furrow and toward the lateral margins by sharp flexure lines. Fine

striæ of growth cross the area and the pedicle furrow parallel to its base. The area of the dorsal valve is partly shown in the figured specimen. It is rather long and marked by numerous fine transverse striæ. The only interior markings preserved are traces of the main vascular sinus in the ventral valve and a portion of the narrow ridge on each side of the central groove of the vascular cavity.

Observations.—This is a large fine species that occurs in the siliceous slates at Point Levis. It may be compared with the Lower Ordovician species, *Obolus selwyni* (Matthew) and *Lingulella (Lingulepis) roberti* (Matthew).

Billings [1862b, p. 72] states that a single valve, found in the "Calciferous sandrock" at the eastern end of the island of Montreal, is rather strongly convex, especially on the umbonal.

FORMATION AND LOCALITY.—**Lower Ordovician**: (**319a** [Billings, 1862b, p. 72]) Levis shales, Point Levis, Quebec, Canada.

LINGULELLA IRIS (Billings).

Plate XXVII, figure 2.

Lingula iris BILLINGS, 1865, Geol. Survey Canada, Paleozoic Fossils, vol. 1, p. 301, fig. 290. (Described as a new species, see below for copy. The specimen represented by fig. 290 is redrawn in this monograph, Pl. XXVII, fig. 2.)

The original description by Billings follows:

Shell small, subovate; sides parallel, or nearly so, in the lower two-thirds gently convex or somewhat straight; in the upper one-third converging to the beak with a convex slope; beak narrowly rounded; anterior angles rounded; anterior margin, with a portion in the middle, somewhat straight. The only specimen collected is gently convex, a somewhat flat space along the middle, and a flat or gently convex slope on each side to the margin in the upper two-thirds. Surface with obscure radiating and concentric striæ. Length, 4½ lines; width, 3¼ lines.

The only specimen of this species in the collection of the Geological Survey of Canada is the one described by Billings [1865a, p. 301]. It is a dorsal valve with an outline somewhat like that of *Lingulella arguta* (Walcott) [Pl. XXIV, fig. 5a].

The character of the limestone matrix and the small fragments of trilobites embedded in it indicate that the specimen was taken from one of the bowlders of Cambrian limestone embedded in the Ordovician limestone No. 2 of the Point Levis section [Walcott, 1890a, p. 111].

FORMATION AND LOCALITY.—**Upper Cambrian**: (**319d** [Billings, 1865a, p. 301]) Limestone bowlder in Lower Ordovician conglomerate, Point Levis, Quebec, Canada.

LINGULELLA ISSE (Walcott).

Text figures 43A–F, page 510, and Plate XXXIX, figures 4, 4a–b.

Obolus (Lingulella) isse WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 330. (Characterized as a new species.)

This shell is rather strong and made up of several thin layers or lamellæ. Its outer surface is marked by concentric lines of growth, sometimes grouped in more or less elevated bands, and over all there is a thin encrusting or scabrous layer that has a minutely granular, dull surface, somewhat like that of *Lingulella (Lingulepis) gregwa* (Matthew), but very much finer in its granulations or points. The inner layers of the shell are dark, shiny, and marked by concentric lines of growth and radiating striæ.

The longest ventral valve has a length of 16 mm. The proportions of length and breadth of the valves are as follows:

Dimensions, in millimeters, of valves of Lingulella isse (Walcott).

		Length.	Width.
Ventral valves	Elongate	16	9
	Medium	10	7
	Short and broad	11	9
Dorsal valves	Elongate	6.5	4.5
	Medium	5	4.5
	Medium	11	8.5
	Short and broad	10.5	9

Observations.—The ventral valves of *Lingulella isse* have an outline very similar to that of *Lingulella pogonipensis* (Walcott) and *L. acutangula* (Roemer) (Pl. XVII), but the dorsal valves are more subquadrate in outline, and even the elongate form of the dorsal valve is more obtusely rounded. The species has a considerable vertical distribution in the House Range section. It is first met with 950 feet (289.6 m.) above the Middle Cambrian, and again at the 1,150 (350.5 m.) and 1,400 foot (426.7 m.) horizons. Fragments of a closely allied species occur near the summit of the Upper Cambrian, 2,800 feet (853.4 m.) above the Middle Cambrian, and a single dorsal valve was collected from the Weeks limestone of the Middle Cambrian, 650 feet (198 m.) below the base of the Upper Cambrian. If these two somewhat doubtful, but still closely allied, shells are identical the known vertical range of the species is 3,450 feet (1,052 m.), a range that may be compared with that of *Obolus mcconnelli* (p. 397) and *L. desiderata* (p. 493).

The original description of the species [Walcott, 1905a, p. 330] referred it to the Middle Cambrian, but later collections from the House Range section show this reference to have been incorrect, as the associated fauna occurs in the Orr formation 30 miles to the south.

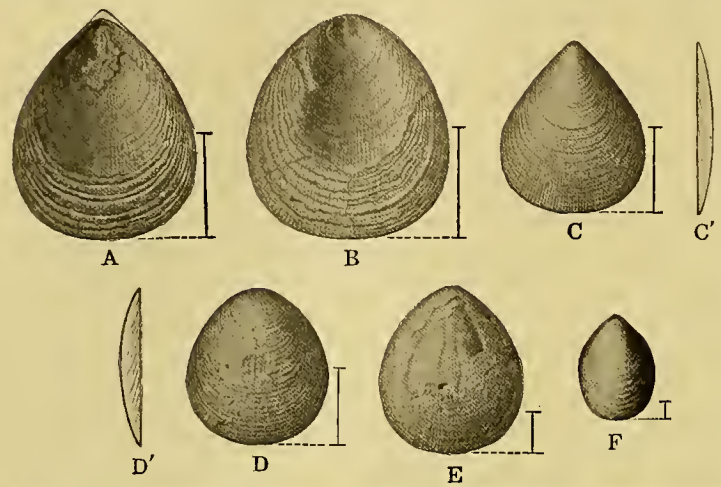

FIGURE 43.—*Lingulella isse* (Walcott). A, Ventral valve flattened and distorted in the shale (U. S. Nat. Mus. Cat. No. 51809a). B, Dorsal valve flattened in the shale (U. S. Nat. Mus. Cat. No. 51809b). C, C′, Ventral valve (U. S. Nat. Mus. Cat. No. 56998a). D, D′, Dorsal valve (U. S. Nat. Mus. Cat. No. 56998b). E, Dorsal valve (U. S. Nat. Mus. Cat. No. 56998c). F, Young shell tentatively referred to this species (U. S. Nat. Mus. Cat. No. 56998d).

The specimens represented by figures 43A and 43B are from Locality 30k; those represented by figures 43C, 43D, 43E, and 43F are from Locality 30j; both in the Upper Cambrian limestones of the Orr formation, House Range, Millard County, Utah.

FORMATION AND LOCALITY.—**Upper Cambrian: (15d)**[a] *Thin-bedded blue limestone near Cave Spring on the east side of the Fish Spring Range, about 4 miles (6.4 km.) south of the J. J. Thomas ranch;* and (**33d**) thin-bedded blue limestone from the same horizon as locality No. 15d at the base of the first high point southwest of the J. J. Thomas ranch, on the east side of the Fish Spring Range; both in Juab County, Utah.

(**30j**) 950 feet (289.6 m.) above the Middle Cambrian and 2,450 feet (746.8 m.) below the top of the Upper Cambrian, near the base of the arenaceous shales and limestone forming 1e of the Orr formation [Walcott, 1908f, p. 176], on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass; (**30k**) 1,150 feet (350.5 m.) above the Middle Cambrian and 2,175 feet (662.9 m.) below the top of the Upper Cambrian, at the top of the arenaceous shales and limestones forming 1e of the Orr formation [Walcott, 1908f, p. 176], on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass; (**30y**) about 1,400 feet (426.7 m.) above the Middle Cambrian and 1,900 feet (579.1 m.) below the top of the Upper Cambrian in the supposed metamorphosed equivalent of the shales forming 1b of the Orr formation [Walcott, 1908f, p. 176], above the granite contact on top of the ridge north of Notch Peak; (**31q**) about 2,800 feet (853.4 m.) above the Middle Cambrian and 500 feet (152.4 m.) below the top of the Upper Cambrian in the gray limestone forming 1a of the Notch Peak limestone [Walcott, 1908f, p. 175], on the north slope of Notch Peak; all in the House Range [Walcott, 1908f, Pls. XIII and XIV], Millard County, Utah.

(**34r** and **34t**) Limestone 1.5 miles (2.4 km.) northwest of Wahwah Springs, on the north side of the road at Cane Pass, Wahwah Mountains, Beaver County; (**32g**) about 2,575 feet (784.9 m.) above the Cambrian quartzitic sandstones in a blue limestone about 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range, Tooele County; and (**30s**) green shale about 1,200 feet (365.8 m.) above the Cambrian quartzitic sandstones on the pipe line above the limekiln in Ogden Canyon 1 mile (1.6 km.) above its mouth, east of Ogden, Weber County; all in Utah.

(**31i**) Limestone 0.75 mile (1.2 km.) east-northeast of McGill post office, White Pine County, Nevada.

(**57d**) About 3,215 feet (980 m.) above the Middle Cambrian and 375 feet (114.3 m.) below the top of the Upper Cambrian in green shales near the summit of 2b of the Sherbrooke limestone [Walcott, 1908f, p. 204], on ridge west of Mount Bosworth, on the Continental Divide between Alberta and British Columbia, just north of the Canadian Pacific Railway, Canada.

[a] The species also occurs in Locality 34i (p. 196).

Middle Cambrian: (**30n**) About 3,750 feet (1,143 km.) above the Lower Cambrian and 650 feet (198 m.) below the Upper Cambrian in the shaly limestones forming 1c of the Weeks limestone [Walcott, 1908f, p. 175], on the north side of Weeks Canyon, about 4 miles (6.4 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County; and (**31y**) thin-bedded limestone about 125 feet (38 m.) above the Cambrian quartzitic sandstones, in the Wasatch Mountains, 1 mile (1.6 km.) northwest of Geneva, east of Brigham, Boxelder County; both in Utah.

(**54s**) Dark blue-gray Langston limestone [Walcott, 1908f, p. 198], just above the Cambrian quartzitic sandstones, north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

(**57n**)[a] About 3,000 feet (914.4 m.) above the Lower Cambrian and about 700 feet (213.4 m.) above the base of a limestone correlated with No. 4 of the Eldon limestone on Mount Bosworth [Walcott, 1908f, p. 209], on the northwest slope of Mount Stephen, above Field on the Canadian Pacific Railway, British Columbia.

Lingulella kiurensis (Waagen).

Plate XXX, figures 5, 5a, 6, 6a.

Lingula? kiurensis Waagen, 1885, Mem. Geol. Survey India, Paleontologia Indica, 13th ser., Salt Range Fossils, vol. 1, pt. 4, fas. 5, pp. 768–769, Pl. LXXXVI, figs. 8a–b. (Described and discussed as a new species, see below. The specimen represented by figs. 8a–b is redrawn in this monograph, Pl. XXX, fig. 6.)

Lingula? warthi Waagen, 1885, idem, pp. 769–770, Pl. LXXXVI, figs. 9a–b. (Described and discussed as a new species. The specimen represented by figs. 9a–b is redrawn in this monograph, Pl. XXX, fig. 5.)

Lingula? kiurensis Waagen, 1891, idem, vol. 4, pt. 2, Pl. II, figs. 17a–b. (No text reference. Figures copied from those representing *L. warthi* Waagen, 1885, Pl. LXXXVI, figs. 9a and 9b. Figures 17a–b are reproduced in this monograph, Pl. XXX, fig. 5a.)

Lingula? warthi Waagen, 1891, idem, vol. 4, pt. 2, Pl. II, figs. 18a–b. (No text reference. Figures copied from those representing *L. kiurensis* Waagen, 1885, Pl. LXXXVI, figs. 8a and 8b. Figs. 18a–b are reproduced in this monograph, Pl. XXX, fig. 6a.)

Through the courtesy of the director of the Geological Survey of India, Mr. T. H. Holland, I have had the opportunity of studying the type specimens of the two species described by Waagen. Of *Lingulella kiurensis*, Waagen mentions [1885, p. 769] that he had a single specimen, which he considered to be a ventral valve. He also had but one specimen of the second species, "*Lingula? warthi*," which he could not decide as either a ventral or dorsal valve. I find that the two specimens are from the same locality and from the same bed of rock. Waagen stated [1885, p. 770] that he long considered them as belonging to the same species, but owing to the existence of a "reticulation" on the lateral parts of "*L.? warthi*" he decided to separate the latter as a distinct species. In a reflected light I find traces of the "reticulation" on the outer portions of *L. kiurensis*, and it is quite common in an arenaceous matrix to find shells from which the finely reticulated outer surface has been abraded. My interpretation of the two specimens is that they represent one species, and that Waagen's type of "*Lingula? warthi*" is the ventral valve and the type of his "*Lingula? kiurensis*" the dorsal valve. Carefully made drawings have been prepared of the two type specimens, and beside them are reproduced the somewhat diagrammatic figures accompanying Waagen's description.

In 1891 Waagen refigured [1891, Pl. II, figs. 17a–b] the specimen which he described in 1885 [1885, p. 769] as "*Lingula warthi*" and labeled it "*Lingula? kiurensis.*" Similarly, the specimen which he described [1885, p. 768] as "*Lingula? kiurensis*" is [1891, Pl. II, figs. 18a–b] labeled "*Lingula? warthi.*"

The original description by Waagen follows:

> The general form of the shell is an elongate oval with the ventral valve slightly more acuminate than the dorsal; original convexity unknown, as both specimens are flattened in the matrix and one is slightly crushed. Surface marked by round striæ of growth that vary in size, and a few narrow, irregular, rounded, radiating ribs on the sides.

Waagen [1885, p. 768] described this species under the impression that it was from the *Productus* limestone of the Carboniferous. Subsequently, this view was modified on account of the discovery of Cambrian fossils by Warth. The history of the discoveries and discussion is very clearly presented by Noetling [1894, pp. 71–86] in an article on the "Cambrian formation of the Salt Range."

The first impression made by this shell when comparing it with other species of *Lingulella* is that it is an Upper Cambrian type. Its broad oval outline is not unlike that of *Lingulella*

[a] The species is somewhat doubtfully identified from this locality.

bella (Walcott), of Newfoundland, *Lingulella davisi* (McCoy), of Wales, *L. mosia osceola* (Walcott), and *Obolus* (*Westonia*) *stoneanus* (Whitfield), of Wisconsin. No such forms are known to me from the Lower Cambrian, and the broad shells from the Middle Cambrian are usually more acuminate.

The specific name is derived from Kiura, the type locality.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**357** [Waagen, 1885, p. 769]) Limestones in the "*Neobolus* beds" of the Khussak group; above the salt mines at Kiura (Khewra), Salt Range, India.

LINGULELLA LÆVIS Matthew.

Plate XIX, figures 4, 4a–b.

Lingulella lævis MATTHEW, 1892, Trans. Roy. Soc. Canada for 1891, 1st ser., vol. 9, sec. 4, No. 5, p. 39, Pl. XII, figs. 4a and 4b. (Described as a new species, see below for copy. The specimens represented by figs. 4a and 4b are redrawn in this monograph, Pl. XIX, figs. 4a and 4, respectively.)

The original description by Matthew follows:

A large oval-ovate species, with a very thin test, resembling a *Lingula* in its thin hinge line, and having a pedicle groove.

The shell has a smooth, shining surface, but when observed with a lens very fine concentric and fainter radiating lines are made visible.

Ventral valve, length, 15 mm.; width, 11 mm. Dorsal valve, length, 14 mm.; width, 11 mm. Another dorsal valve is 17 mm. long and 15 mm. wide.

This is a very interesting species on account of the thinness of the shell and the unusual outline of the dorsal valve. It is unfortunate that the material for study does not show the interior of the valves.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**301n**) Shales of Division C3a of Matthew [1892, p. 39], on the right shore below the "falls," St. John Harbor, St. John County, New Brunswick.

LINGULELLA LÆVIS GRANDIS Matthew.

Plate XIX, figure 4c.

Lingulella lævis grandis MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 200–201, Pl. XV, figs. 1a–d. (Described and discussed as a new variety. The specimen represented by fig. 1d is redrawn in this monograph, Pl. XIX, fig. 4c.)

Matthew considers this shell a variety of *Lingulella lævis*. It is somewhat larger, but a good series of specimens would probably unite the two forms. Matthew [1903, p. 201] gives a very elaborate description of the interior of the valves. He sent me the type of the dorsal valve, which is illustrated (fig. 4c). I could not discover many of the markings indicated in his illustration, but the latter may be a composite drawing.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**325b** [*Matthew, 1903, desc. of Pl. XV*]) *Sandy shales of Division C3a of Matthew, at Escasonie shore, East Bay, east of Bras d'Or Lake, in eastern Cape Breton, Nova Scotia.*

(**301t** [Matthew, 1903, p. 201]) Sandy shales of Division C3a of Matthew, at Carlton shore, near the suspension bridge, St. John, St. John County, New Brunswick.

LINGULELLA LENS (Matthew).

Plate XXXIII, figures 1, 1a–d.

Lingula ? lens MATTHEW, 1901, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 4, No. 19, pp. 274–275, Pl. V, figs. 3a–h, (Described and discussed as a new species. The specimen represented by fig. 3a is redrawn in this monograph, Pl. XXXIII, fig. 1.)

Obolus (*Lingulella*) *bellus* WALCOTT (in part), 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 685–687. (Matthew's "*Lingula lens*" is here described with, and referred to, "*Obolus* (*Lingulella*) *bellus*.")

Obolus (*Lingulella*) *lens* (Matthew), WALCOTT, 1902, idem, vol. 25, pp. 606–607. (Described and discussed as a distinct species.)

Lingulella lævis lens MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 201–203, Pl. XV, figs. 3a–h. (Matthew's original "*Lingula ? lens*" is here described and discussed as a variety of *Lingulella lævis*. The description is an essential copy of and the figures are copied from Matthew, 1901, pp. 274–275, Pl. V, figs. 3a–h.)

Lingulella lens MATTHEW, 1903, idem, pp. 205–206. (Discussed as not belonging under *Westonia*.)

Not *Obolus (Palæobolus) lens* MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 144–146, Pl. X, figs. 1a–f. (Referred in this monograph to *Obolus (Palæobolus) bretonensis lens.*)

General form broadly ovate. The ventral valve is subacuminate and the dorsal valve very broadly ovate to subsemicircular. The convexity of the valves is moderate, the ventral valve being most prominent along the center, with the posterolateral slopes somewhat flattened toward the margin.

Surface of the shell marked by fine, concentric striæ and lines of growth, and the inner surface by concentric lines and very fine radiating striæ. The shell is thinner than most species of the genus, resembling in this respect *Obolus? murrayi* Billings, *Lingulella lævis* Matthew, and *L. bella* (Walcott). It is formed of several layers or lamellæ that are slightly oblique to the outer layer. Matthew [1901, p. 274] speaks of minute pits on the outer surface. These also appear on the inner layers. I have been unable to determine whether the thin calcareous crust mentioned by Matthew [1901a, p. 274] is really the true outer layer or simply a thin calcareous deposit.

The largest specimen of a dorsal valve in the collection has a length of 15 mm., with a width of 13 mm. The corresponding ventral valve was probably 1 or 2 millimeters longer.

Observations.—In the material collected by Loper in 1901 there are some specimens that show the form of the ventral and dorsal valve of this species. The shell is broader and rounder than I supposed when studying the material Matthew sent me. It is quite distinct from *Lingulella bella* (Walcott) and *L. concinna* Matthew, with which I placed it. The interior markings are those of *Lingulella*, but it may be that more perfect material would prove it to belong to one of the subgenera of *Obolus*.

Matthew [1903, p. 201] refers to this form as a variety of *Lingulella lævis*. With the material from Cape Breton and Newfoundland for comparison, I am not sufficiently sure to follow him in this, as it appears to be specifically distinct from *lævis*.

Further remarks on this species occur under *Lingulella concinna* (p. 487).

FORMATION AND LOCALITY.—Upper Cambrian: (10r)[a] Thin calcareous layers in the arenaceous shales of Division C3a? of Matthew at McAdam shore, East Bay, east of Bras d'Or Lake, eastern Cape Breton, Nova Scotia.

LINGULELLA LEOS (Walcott).

Plate XXIV, figures 2, 2a–c.

Obolus (Lingulella) leos WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 407–408. (Described and discussed essentially as below as a new species.)

Shell small; general form elongate ovate with the ventral valve subacuminate. The valves are rather strongly convex in the narrow form of the species. Average length of a ventral valve is 5 mm.; the largest ventral valve has a length of 6 mm.; the dorsal valve is somewhat shorter. The width of the valve varies considerably in shells occurring in the same hand specimens in the limestone. This is shown by Plate XXIV, figures 2 and 2a, for the ventral valve, and 2b and 2c for the dorsal valve. The surface of the shell is marked by fine concentric lines and striæ of growth, and very fine, interrupted, radiating striæ; casts of the interior of the shell show stronger radiating striæ than the outer surface; also in many specimens unusually large papillæ that fill the pits or punctæ of the inner surface. The number and strength of the papillæ vary in different casts. The shell appears to have been rather thin, and formed of a thin outer layer and one or more thin inner layers or lamellæ.

Casts of the interior of the ventral valve show a well-defined area, divided midway by the cast of a strong pedicle groove. The area of the dorsal valve is obscured by adhering fragments. On casts of the ventral valve traces of the visceral cavity (v) and the main vascular sinuses (vs) occur, and in the dorsal a narrow, long median sinus is clearly defined; also the casts of the central and anterior lateral muscle scars (Pl. XXIV, figs. 2b and 2c).

[a] 10r is the type locality, though the specimens in the United States National Museum collections to which that number is assigned were collected later than the type specimens.

Observations.—This neat little species in some respects resembles *Lingulella similis* (Walcott). It differs, as may be seen by comparing Plate XXIV, figures 2, 2a–c, with Plate XXI, figures 2, 2a–c, in being more elongate, the interior more strongly punctate, and in the more anterior position of the central muscle scars in the dorsal valve.

FORMATION AND LOCALITY.—**Upper Cambrian:** (96) Limestones near the ford on the Cedartown road, 1.5 miles (2.4 km.) south of Rome, Floyd County, Georgia.

LINGULELLA LEPIS (Salter).

Plate XXXI, figures 4, 4a–f.

Lingula lepis SALTER, 1859, Siluria, by Murchison, 3d ed., p. 543.

Lingulella lepis SALTER, 1866, Mem. Geol. Survey Great Britain, vol. 3, p. 334, fig. 11. (Described and discussed as a new species.)

Lingula? lepis Salter, DAVIDSON, 1866, British Fossil Brachiopoda, vol. 3, pt. 7, No. 1, p. 54, Pl. III, figs. 53–59. (Described and discussed. Figs. 53–56 are reversed views of Salter, 1866b, p. 334. fig. 11.)

Lingula (*Lingulella*) *lepis* (Salter), DAVIDSON, 1866, idem, description of Plate III. (Merely changes generic reference.)

Lingulella lepis (Salter), DAVIDSON, 1868, Geol. Mag., vol. 5, pp. 307–308, Pl. XV, figs. 10–12. (Discussed. Figs. 10 and 10a are copied (reversed) from the upper two of Salter's figures, 1866, p. 334, fig. 11.)

Lingulella lepis (Salter), DAVIDSON, 1871, British Fossil Brachiopoda, vol. 3, pt. 7, No. 4, Pl. XLIX, figs. 31 and 31a. (Figs. 31 and 31a are reproduced in this monograph, Pl. XXXI, figs. 4a and 4, respectively.)

Lingulella lepis (Salter), SALTER and ETHERIDGE, 1881, Mem. Geol. Survey Great Britain, vol. 3, 2d ed., p. 538, fig. 11. (A copy of Salter, 1866b, p. 334, fig. 11.)

Lingula (*Lingulella?*) *lepis* (Salter), BRÖGGER, 1882, Die silurischen Etagen 2 und 3, p. 44, Pl. X, figs. 5, 5a–b. (Occurrences mentioned in German.)

Lingulella lepis (Salter), HOLM, 1898, Geol. Fören. i Stockholm Förhandl., Bd. 20, p. 148. (Occurrences mentioned in Swedish.)

Lingulella lepis (Salter)?, WIMAN, 1902, Bull. Geol. Inst. Univ. Upsala, vol. 6, pt. 1, No. 11, pp. 66 and 71. (Occurrences mentioned in German.)

Lingulella cf. *lepis* (Salter), MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 204. (New locality mentioned.)

Lingulella lepis (Salter), MOBERG and SEGERBERG, 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), pp. 62–63, Pl. I, fig. 20. (Occurrences discussed in Swedish.)

Lingula? corrugata MOBERG and SEGERBERG, 1906, idem, p. 63, Pl. I, fig. 21. (Characterized in Swedish as a new species.)

Lingula? bryograptorum MOBERG and SEGERBERG, 1906, idem, p. 63, Pl. I, fig. 22. (Characterized in Swedish as a new species.)

Lingula? producta MOBERG and SEGERBERG, 1906, idem, p. 63, Pl. I, fig. 23. (Described in Swedish as a new species.)

Lingula? ordovicensis MOBERG and SEGERBERG, 1906, idem, p. 63, Pl. I, fig. 24. (Described in Swedish as a new species.)

Lingulella lepis Salter?, WESTERGÅRD, 1909, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 4 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 20), p. 56, Pl. II, figs. 17–19. (Discussed in Swedish. Figs. 17 and 18 are copied from Moberg and Segerberg, 1906, Pl. I, figs. 28 and 27, respectively.)

Lingula? corrugata Moberg and Segerberg, WESTERGÅRD, 1909, idem, p. 57, Pl. II, fig. 23. (Characterized in Swedish. Fig. 23 is copied from Moberg and Segerberg, 1906, Pl. I, fig. 21.)

Lingula? bryograptorum Moberg and Segerberg, WESTERGÅRD, 1909, idem, p. 57, Pl. II, figs. 24a–b. (Characterized in Swedish. Figs. 24a–b are copied from Moberg and Segerberg, 1906, Pl. I, figs. 22a–b, respectively.)

I was in doubt about this species until after studying a fine series of specimens collected for me by Schmalensee at various localities in Sweden. The Swedish shells, in a limestone matrix, have a broader outline than the typical forms of *Lingulella ferruginea*, in a limestone matrix, although some of the latter are as broad when flattened in the matrix. When the shells of *L. lepis* are compressed laterally they look very much like those of *L. ferruginea* Salter. Under like conditions of preservation they appear to be distinct. The interior surface is marked by concentric lines of small pits. The outer surface varies from an almost smooth and polished surface marked by concentric lines of growth to a broken surface marked by concentric lines and radiating, more or less irregular, raised ribs. All the characters known are illustrated on Plate XXXI.

The American representative of this species, *Lingulella bella* (Walcott), which has a stratigraphic range similar to that of the shell from Wales, from the Upper Cambrian into the Lower

Ordovician, appears to be a much larger shell. In Norway and Sweden it occurs in the *Ceratopyge* limestone. Compressed and flattened shells from the *Paradoxides davidis* zone of Manuels Brook, Newfoundland, strongly suggest this species, but no similar forms occur in the calcareous layers interbedded in the shales, although *L. ferruginea* Salter is abundant in both limestone and shale.

Moberg and Segerberg [1906, pp. 62–63] have described and illustrated five species of small *Lingulella*-like shells from the *Ceratopyge* zone of Sweden. The form illustrated as *Lingulella lepis* (Salter) [Moberg and Segerberg, 1906, Pl. I, fig. 20] is a dorsal valve of that species from the *Dictyograptus* zone. The form given the name *Lingula? corrugata* Moberg and Segerberg [1906, Pl. I, fig. 21] is from the lower portion of the *Dictyograptus* zone and appears to be a partly exfoliated dorsal valve of *L. lepis*. Of the remaining two species, the one named *Lingula? ordovicensis* Moberg and Segerberg [1906, Pl. I, fig. 24] is much like the ventral valve of *L. lepis* as illustrated on Plate XXXI, figure 4b, of this work, and the other, *Lingula? producta* Moberg and Segerberg [1906, Pl. I, fig. 23], appears to be a similar shell laterally compressed. I have a series of specimens from the *Ceratopyge* limestone of Norway and Sweden that indicate that the species had a considerable range of variation, in this respect resembling *L. ferruginea* Salter (Pl. XXIX, figs. 1 and 2); in fact the variations of the latter species nearly include the forms referred to *L. lepis* (Pl. XXXI, figs. 4, 4a–f). It may be that Moberg and Segerberg's specific names should be retained, but with the information now available I am inclined to consider them all as synonyms of *L. lepis*.

The specific name is derived from λεπίς, a scale.

Formation and locality.—**Passage beds** from the Upper Cambrian to the Ordovician: (**8x**) *Ceratopyge* limestone at Slemmestad, about 3 miles (4.8 km.) southwest of Christiania; (**323f** and **323h** [Brögger, 1882, pp. 16–17]) *Ceratopyge* limestone at Vestfossen, 10 miles (16.1 km.) west-southwest of Christiania; and (**323c** [Brögger, 1882, p. 44]) *Ceratopyge* limestone in the Christiania region; all in Norway.

(**320w** [Holm, 1898, p. 148]) *Ceratopyge* limestone at Glöte in Herjeådalen, Province of Jemtland; (**310** [Moberg and Segerberg, 1906, p. 63]) *Ceratopyge* limestone (zone 4) at Ottenby, Oeland Island; (**310j**) *Ceratopyge* limestone at Borgholm, Oeland Island; (**310w** [Westergård, 1909, desc. of Pl. II]) zone *c* at Grönhögen, Oeland Island; and (**309** [Moberg and Segerberg, 1906, p. 63]) *Ceratopyge* limestone (zone 4) at Fogelsång, 5 miles (8 km.) east of Lund, Province of Malmöhus; all in Sweden.

Upper Cambrian: (**9f**) Limestones of the *Olenus* zone at Nœrsnæs, west of Christiania; and (**323a** [Wiman, 1902, p. 66]) *Ceratopyge* slate in the Christiania region; both in Norway.

(**321l**[b] and **321m**[b]) Drift bowlders of *Ceratopyge* slate, Nos. 14, 17, and 27 [Wiman, 1902, p. 68], on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg; (**309a** [Moberg and Segerberg, 1906, p. 62]) *Bryograptus* slate (zone 2) at Fogelsång, 5 miles (8 km.) east of Lund, Province of Malmöhus; (**310d**) *Ceratopyge* slate at Borgholm, Oeland Island; and (**309b** [Moberg and Segerberg, 1906, p. 63]) *Dictyograptus* slate (zone 1) at Flagabro, Province of Malmöhus; all in Sweden.

(**305a** [Davidson, 1866, desc. of Pl. III]) Upper Tremadoc beds at Moel-y-gest, northwest side, Carnarvonshire; (**366q** [Davidson, 1866, p. 54]) Upper Tremadoc beds at Garth, opposite Portmadoc, Merionethshire; (**305e** [Davidson, 1866, p. 54]) Upper Tremadoc beds near Tai-hirion, Arenig; (**305c**) Lower Tremadoc slate, everywhere in the Tremadoc district, Carnarvonshire; (**305d**)[a b] Upper *Lingula* flags near Tremadoc, Carnarvonshire; (**305f**)[a] Lower Tremadoc, east of Port Nant-y-Ladron, on the Bala Road from Ffestiniog, Merionethshire; (**305g**)[a] Lower Tremadoc at Wern; (**305h**)[a] *Lower Tremadoc at Borthwood;* (**305i**)[a] Lower Tremadoc at Trwyn-y-Iago; and (**305j**)[a] Lower Tremadoc at Cefn Cyfarnedd; all in North Wales.

(**307a** [Matthew, 1903, p. 240])[b] Shales of Division C3c2 of Matthew, on McLeod Brook (=Barachois River), near Boisdale, eastern Cape Breton, Nova Scotia, Canada.

(**301e**)[b] Beds of Division C3a of Matthew; and (**301u**) shales of Division C3b of Matthew; both [Matthew, 1903, p. 204] in the St. John Basin, St. John County, New Brunswick, Canada.

Lingulella lineolata (Walcott).

Plate XLVIII, figures 2, 2a–l.

Obolus (*Lingulella*) *lineolatus* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 408–409. (Described and discussed essentially as below as a new species.)

General form ovate, with the ventral valve subacuminate, and the dorsal valve ovate to broad ovate. The range of variation in the outline of the valves is quite strongly marked; this

[a] Davidson, 1866, p. 54.

[b] The species is somewhat doubtfully identified from this locality.

may be seen by comparing Plate XLVIII, figures 2a, 2e, 2i, and 2k of the ventral valve and figures 2b, 2c, 2d, 2f, and 2g of the dorsal valve. The convexity of the valves is moderate, that of the dorsal valve being a little more than that of the ventral (fig. 2j).

The surface of the shell is marked by concentric lines and striæ of growth, with very fine, concentric striæ between them that are sometimes slightly undulating; on some specimens very faint radiating striæ can be seen with a strong lens; when the outer layer is exfoliated the inner layer is marked by fine radiating and concentric striæ in addition to the stronger concentric striæ; as far as can be determined from the imperfect casts of the interior the inner surface of the shell was nearly smooth. The shell appears to be formed of a very thin outer layer and one or more thin inner layers or lamellæ; toward the frontal margins the oblique lamellæ increase in number, but do not give any considerable thickness to the shell.

One of the largest of the ventral valves referred without doubt to this species has a length of 7 mm. and a width of 5.5 mm. An associated dorsal valve is slightly shorter in proportion to the width. The average size is smaller, not exceeding 5 mm. for the length of the ventral valve. One unusually large ventral valve that is referred to this species with some doubt has a length of 9 mm.

The only traces of the interior of the shell that have been observed are portions of the cardinal area and pedicle furrow of the ventral valve (Pl. XLVIII, fig. 2j) and the cardinal area of a dorsal valve (Pl. XLVIII, figs. 2f and 2 l).

Observations.—This species is very abundant in the upper beds of the "Tonto" sandstone. It is associated with *Obolus* (*Westonia*) *euglyphus* (Walcott), and it is often difficult when the two are in the form of imperfect casts, to distinguish between the larger specimens of the two species. They are readily distinguished, when the shells are well preserved, by the difference in surface markings and the more acuminate ventral valves of *Lingulella lineolata*. The latter character, however, is not always of service, especially in the larger shells. In form the ventral valve of this species may be compared with *L. acutangula* (Roemer) (Pl. XVII).

FORMATION AND LOCALITY.—**Middle Cambrian:** (**9o**) Siliceous limestone about 15 feet (4.5 m.) above the Coronado quartzite [Lindgren, 1905, p. 3], 0.5 mile (0.8 km.) southwest of Milk ranch, on the first spur north of the one which the main road follows; and (**358**) argillaceous shale, 50 feet (15.2 m.) above the Coronado quartzite [Lindgren, 1905, p. 3], west side of Chase Creek Canyon, 1.5 miles (2.4 km.) east-northeast of Morenci; both in the Clifton quadrangle (U. S. Geol. Survey), Graham County, Arizona.

(**73**) *Sandstones of the Tonto group, in Kwagunt Valley;* (**73a**) sandstones of Tonto group, in Chuar Valley; (**74**) sandstone about 300 feet (91.4 m.) above the base of the Tonto group, at the head of Nunkoweap Valley; (**74d**) sandstone beds in "Tonto" shale, just above massive sandstones near the mouth of Bass Canyon, on the south side of the Grand Canyon, southeast of Powell Plateau; and (**17c**) sandy limestone 235 feet (71.6 m.) above the "Tonto" sandstone, Grand View trail, north of Last Chance copper mine, south side of the Grand Canyon; all in the Graud Canyon of the Colorado, Arizona.

LINGULELLA LINNARSSONI (Walcott).

Plate XXX, figures 14, 14a.

Obolus (*Lingulella*) *linnarssoni* WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 688. (Described as below as a new species.)

Ventral valve elongate oval, subacuminate. Surface marked by fine, undulating, depressed, radiating, ridgelike lines; closely undulating, concentric striæ; and very fine papillæ that appear to terminate in fine sharp points; the papillæ are situated on the narrow, irregular, elevated spaces between the striæ. Shell relatively thin and formed of several lamellæ more or less oblique to the outer surface.

Observations.—The species is based on a fine specimen of a ventral valve associated with *Billingsella lindströmi* (Linnarsson) in the *Paradoxides* series of Lovened. It is broader than *Lingulella ferruginea* Salter and the surface ornamentation is quite different. The latter is more like that of the associated *Acrothele coriacea* Linnarsson. In outline it approaches more nearly to *L. lepis* (Salter).

The specific name was given in honor of Mr. J. G. Linnarsson.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**320n**) Limestones of the *Paradoxides forchhammeri* zone at Lovened, Djupadal, 19 miles (30.6 km.) south-southeast of Skara, Province of Skaraborg, Sweden.

Lingulella manticula (White).

Plate XX, figures 1, 1a–c.

Lingula? manticula White (in part), 1874, U. S. Geog. Surveys W. 100th Mer.; Prelim. Rept. Invertebrate Fossils, pp. 9–10. (Described as a new species, including specimens referred to both *Lingulella manticula* and *L. arguta*.)

Lingula manticula White (in part), 1877, U. S. Geog. Surveys W. 100th Mer., vol. 4, pt. 1, p. 52, Pl. III, fig. 2b (not fig. 2a). (Described essentially as in the preceding reference and discussed. The specimen represented by fig. 2b could not be located when the drawings of this species were being made, and the original drawing is reproduced in this monograph, Pl. XX, fig. 1c. The specimen represented by fig. 2a is referred in this monograph to *Lingulella arguta*.)

Not *Lingula? manticula* Walcott, 1884, Mon. U. S. Geol. Survey, vol. 8, pp. 13–14, Pl. IX, fig. 3; and Pl. XI, fig. 2. (These specimens are now referred to *Lingulella punctata*.)

Shell small, general form elongate ovate, with the ventral valve subacuminate, and the dorsal valve ovate in outline. Valves rather strongly convex, the ventral being slightly more so along the posterior half than the dorsal. There is some variation in the outline of the valve, as is shown for the ventral by Plate XX, figures 1 and 1c, and for the dorsal by Plate XX, figures 1a and 1b.

Surface of shell marked by fine concentric lines of growth and very fine, slightly irregular concentric striæ; when the outer shell is partly exfoliated the outer surface of the inner layers is marked by fine, concentric lines and not very distinct radiating striæ; the inner surface of the shell shows concentric lines of growth and a few scattered pits or punctæ. The shell is of medium thickness and formed of a thin outer layer and one or more inner layers or lamellæ.

The average length of the ventral valve is 3.5 mm.; width, 2 mm. The associated dorsal valve of the same width has a length of 3 mm.

As shown in the cast of the interior of the shell the area of the ventral valve is long, clearly defined, and broken midway by a narrow but strong pedicle groove. It is also marked near its lateral margins by narrow flexure lines. The striæ of growth cross the area parallel with its base. They are very distinct but do not show on the cast of the pedicle furrow.

The cast of the interior of the ventral valve shows the visceral cavity (v) and the outline of the heart-shaped pit (x). In the dorsal valve sufficient is shown to indicate that the visceral cavity extended forward to about the middle of the shell, and that a narrow median septum was present.

Observations.—This is a small species that is representative of quite a group of somewhat similar forms that occur in the Upper Cambrian and Lower Ordovician faunas, both in the Rocky Mountain and Appalachian regions; *Lingulella punctata* (Walcott) representing the group in the Rocky Mountains, and *L. desiderata* (Walcott) in the Appalachian region.

Of the figures given by White [1877, Pl. III] figure 2b is taken as the type. Figure 2a of White [1877, Pl. III] is a larger shell, which I have referred to *L. arguta*. The specimens identified by Walcott [1884b, p. 13] as "*Lingula? manticula*" have been referred to *L. punctata*, as a comparison with the type of "*L.? manticula*" White shows them to be distinct.

This species was referred to the "Quebec group" by White [1874, p. 9], and it is probable that the horizon at which it occurs will be found to be in the passage beds between the Upper Cambrian and Lower Ordovician, or what corresponds to the lower part of the Pogonip limestone of the Eureka, Nevada, section. Since the preceding was written, Spurr collected a few Cambrian fossils in southern Nevada among which occurs a form that appears to be identical with *L. manticula*. The fragments of trilobites indicate a Cambrian fauna but not its stratigraphic horizon.

Formation and locality.—**Lower Ordovician**: (202) Pogonip limestone, on the summit of the ridge directly southeast of the Jackson mine, northwest of Shadow Canyon, Eureka district [Hague, 1892, Atlas], Eureka County; and (214b) limestone near the middle of the Pogonip limestone, White Pine district, White Pine County; both in Nevada.

Upper Cambrian: (8e) Limestone in Patterson Canyon, west side of the Schell Creek Range; (313f) *limestone at Schellbourne, Schell Creek Range*, and (8f) limestone at summit of canyon, 10 miles (16.1 km.) south of Egan Canyon, east side of Egan Range; all in White Pine County, Nevada.

(**61**) Limestone in the Dunderberg shale [Walcott, 1908f, p. 184], a little south of the Hamburg mine; and (**62**) limestone in the Dunderberg shale [Walcott, 1908f, p. 184], in canyon immediately north of Adams Hill; both in the Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

(**30l**) About 1,400 feet (426.7 m.) above the Middle Cambrian and 1,900 feet (579.1 m.) below the top of the Upper Cambrian in the shales forming 1b of the Orr formation [Walcott, 1908f, p. 176], on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass [Walcott, 1908f, Pl. XIII], House Range, Millard County; (**15d**) thin-bedded blue limestone near Cave Spring, on the east side of the Fish Spring Range, about 4 miles (6.4 km.) south of the J. J. Thomas ranch, Juab County; (**32f**) thin-bedded siliceous limestone near the top of the Upper Cambrian, about 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range, Tooele County; and (**30q**) limestones about 2,300 feet (701 m.) above the Cambrian quartzitic sandstones on pipe line above limekiln, in Ogden Canyon, 1 mile (1.6 km.) above its mouth, east of Ogden, Weber County; all in Utah.

(**54b**) About 1,200 feet (365.8 m.) above the Middle Cambrian, and 25 feet (7.6 m.) below the top of the Upper Cambrian in the limestones forming 1 of the St. Charles formation [Walcott, 1908f, p. 191]; (**31m**) about 175 feet (53.3 m.) above the Middle Cambrian and 1,050 feet (320 m.) below the top of the Upper Cambrian, near the base of the limestones forming 3 of the St. Charles formation [Walcott, 1908f, p. 192]; and (**54e**) about 200 feet (61 m.) above the Middle Cambrian and 1,025 feet (212.4 m.) below the top of the Upper Cambrian, in limestones forming 3 of the St. Charles formation [Walcott, 1908f, p. 193]; all in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

Middle Cambrian: (**7i**) Limestone just west of the summit on the road east of Schellbourne, Schell Creek Range, White Pine County; and (**7j**) limestones at the north end of the Quinn Canyon Range, 1 mile (1.6 km.) northwest of the Italian Ranch foothills, Nye County; both in Nevada.

In the Nounan limestone in southern Idaho there is a narrow, elongate *Lingulella* that is closely allied to *L. manticula*. It differs in being narrower in proportion to the length, in this respect resembling *Lingulella cania* (Walcott) (Pl. XXXV, figs. 3, 3a–d) of Nova Scotia.

Formation and locality.—**Middle Cambrian**: (**56f**) Nounan limestone [Walcott, 1908a, p. 6], in a ridge north of the creek which flows into Mill Canyon from the west, about 5 miles (8 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho.

Lingulella martinensis Matthew

Plate XXXVIII, figures 1, 1a–g.

Lingulella davsoni Matthew (in part) [not (Walcott)], 1886, Trans. Roy. Soc. Canada for 1885, vol. 3, sec. 4, No. 3, pp. 33–34, Pl. V, figs. 9, 9a–c (not fig. 9d). (Described and discussed as a new species, but refers in synonymy to Walcott, 1884a, p. 15. The specimen represented by figure 9d is referred in this monograph to *Lingulella ferruginea*.)

Lingulella martinensis Matthew, 1890, Trans. Roy. Soc. Canada for 1889, 1st ser., vol. 7, pp. 155–156, Pl. VIII, fig. 4. (Described as a new species.)

Lingulella martinensis Matthew, 1895, Trans. New York Acad. Sci. for 1894–5, vol. 14, pp. 113–114, Pl. II, figs. 6a–d. (Described and discussed. Fig. 6a is copied from fig. 4 of the preceding reference. The specimens represented by figs. 6b and 6d are redrawn in this monograph, Pl. XXXVIII, figs. 1d–e, and 1a, respectively. Figs. 1, 1b, 1c are also drawn from specimens in Matthew's type material, but further identification is impossible.)

Lingulella cf. *granvillensis* Walcott, Matthew, 1895, idem, pp. 114–115, Pl. II, figs. 7a and 7b. (Described and discussed.)

General form elongate ovate to subcuneate, with the ventral valve subacuminate, and the dorsal valve elongate ovate; the cardinal slopes of the ventral valve are nearly straight for fully one-half the length of the valve. Ventral valve moderately convex; dorsal valve unusually convex, especially over the umbonal region.

Surface of the shell marked by fine concentric lines of growth, and very fine, irregular raised striæ that form a surface of the type of that of *Lingulella radula* Matthew and *Lingulella* (*Lingulepis*) *roberti* (Matthew). The undulations cause the striæ to touch and blend so as to give the appearance of inosculation and a network of lines. The appearance of the surface markings often varies considerably on different portions of the same valve. The interior surface shows radiating lines and scattered punctæ. The shell is preserved largely as casts of the interior and exterior; it appears to have been built up of a thin outer layer and several inner layers or lamellæ.

The largest ventral valve received from Matthew has a length of 9 mm.; width, 6 mm. The area of the ventral valve is long and divided midway by a narrow, tapering pedicle groove, and toward the lateral margin by a well-marked flexure line. The area of the dorsal valve is unusually long and well marked; the flexure lines are strong and outline a broad, shallow groove between them (Pl. XXXVIII, fig. 1e).

A cast of the ventral valve shows a slight trace of the visceral cavity, also the anterior lateral muscle scars. A few outlines of the vascular markings are preserved in casts of the dorsal valve, also the transmedian and outside or middle lateral muscle scars which occur just within a narrow ridge that borders the somewhat flattened margin of the interior of the valve.

Observations.—The original figure of this species [Matthew, 1890, Pl. VIII, fig. 4] is quite unlike those subsequently given by Matthew [1895a, Pl. II]. The first type must have been distorted, or else it is a different species.

With original specimens to compare and study I consider the specimens referred to *Lingulella* cf. *granvillensis* by Matthew [1895a, p. 114] to be identical with *L. martinensis*. The size and form of the valves, convexity, and surface markings all serve to strengthen this conclusion. The ventral valve, figured by Matthew [1895a, Pl. II, fig. 7a], is an impression in the shale, the cardinal slopes of which have been broken away. The dorsal valve [Matthew, 1895a, Pl. II, fig. 7b] may be compared with the dorsal valve of *L. martinensis* [1895a, Pl. II, fig. 6d].

Matthew [1895a, p. 114] described the occurrence of the central and lateral scars in the ventral valve, but he does not show them in his figures, and I can not clearly see them in the type specimens received from him.

The specific name is derived from St. Martins, in which the type specimens were collected.

Formation and locality.—**Middle Cambrian**: (2g and 2f)[a] *Sandstones of Division 1b1;* (2h) sandstones of Division 1b2; and (2i) sandstones of Division 1b3; all in Matthew's [1895, p. 108] *Protolenus* zone on Hanford Brook, St. John County, New Brunswick.

Lingulella minor (Matthew).

Plate XXXVII, figures 3, 3a–g.

Lingulella starri minor Matthew, 1892, Trans. Roy. Soc. Canada for 1891, vol. 9, sec. 4, No. 5, pp. 58–59, Pl. XI$_1$, figs. 5a–b. (Described and discussed as below. It is a new variety, though not so described. The specimens represented by figs. 5a and 5b are redrawn in this monograph, Pl. XXXVII, figs. 3 and 3a, respectively.)

The original description by Matthew follows:

This neat little species is referred to *Lingulella starri* on account of the sculpture, though it is different both in form and size. It is only about two-thirds of the size of that species, and is more prolonged in front. The dorsal valve also is ovate, not oblately orbicular as in the type.

The sculpture consists of concentric ridges, which appear crenulated owing to the interrupted, faint, radiating ridges that traverse them. At intervals there are stronger concentric lines marking stages of growth. The ridges are not so sharply marked as in *L. starri*, and the shell is much thinner.

Length of ventral valve, 11 mm.; width, 9 mm. The dorsal valve is 1 mm. shorter.

Observations.—The types of *Lingulella starri* are in this monograph referred to *Lingulella* (*Lingulepis*), and the variety *minor* of Matthew [1892, p. 58] to *Lingulella* as a distinct species. During the summer of 1899 I visited the type locality on Long Island, and found this shell in the shales, and also a smaller shell that appears to be the young of *Lingulella minor*, in a fine, compact, shaly sandstone, and in lenticular masses of limestone interbedded in the shales. There is also great variation in outline and size of the shells in the siliceous shale.

Formation and locality.—**Upper Cambrian**: (2x)[b] *Thin-bedded sandstones of Division 2 of Matthew, on the south shore of Long Island, Kennebecasis Bay* [*G. F. Matthew, 1898b, p. 38*], *St. John County, New Brunswick.*

(3n) Thin-bedded sandstones on Salmon River, Gillis Hill, 13 miles (20.9 km.) south of Marion Bridge, eastern Cape Breton, Nova Scotia, Canada.

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[a] 2f is the type locality, though the specimens in the United States National Museum collections to which that number is assigned were collected later than the type specimens.

[b] 2x is the type locality, though the specimens in the United States National Museum collections to which that number is assigned were collected later than the type specimens.

Lingulella mosia (Hall).

Plate XVIII, figures 1, 1a–f.

Lingula mosia Hall, 1863, Sixteenth Ann. Rept. New York State Cab. Nat. Hist., p. 126, Pl. VI, figs. 1–3a. (Described and discussed as a new species; see below.)

Lingula mosia Hall, 1867, Trans. Albany Inst., vol. 5, pp. 102–103, Pl. I, figs. 1–3a. (Copy of preceding reference.)

Lingula mosia Hall, Sardeson, 1896, Bull. Minnesota Acad. Nat. Sci., vol. 4, No. 1, pt. 1, p. 95. (Discussed from a new locality.)

The original description by Hall follows:

Shell small, subelliptical, or ovate-spatulate, little convex, concentrically striated. The slopes below the beak are sometimes nearly straight for a short distance, and often curving from the beak to the base. The specimens are for the most part impressions in sandstone, with little of the shell remaining, but the form is very distinct from any of the described species; and being limited in vertical range, and with a somewhat wide horizontal extension, it becomes of interest in its associations.

The study of a large number of specimens has added little to the knowledge of this species. Nearly all the shell structure has been removed, and only more or less imperfect casts remain in the sandstone. The outer surface is marked by fine concentric striæ and lines of growth, and in one cast there is an indication of irregular, almost inosculating striæ, such as occur on portions of the surface of *Obolus* (*Westonia*) *ella* (Hall and Whitfield). The few fragments of the shell in the material studied indicate that it was of medium thickness and formed of two or more layers, and that the inner lamellæ were marked by fine radiating striæ.

The average size of the ventral valve is about 8.5 mm. in length by 7 mm. in width. The dorsal valve is a little shorter in proportion to the width.

The area of the ventral valve is high; it is broken midway by a strong narrow pedicle groove, and on each side, well out toward the margin, by very narrow flexure lines. Strong striæ of growth cross the area parallel to its base. They arch transversely over the cast of the pedicle furrow. The area of the dorsal valve is well defined; it is crossed by fine striæ of growth, and marked by oblique flexure lines that outline a rather broad space between them.

The casts of the interior of the ventral valve show traces of the visceral cavity and main vascular sinuses, and the central and anterior lateral muscle scars have been seen in the dorsal valve.

Observations.—The broad, almost subquadrate outline of some of the specimens of the dorsal valve suggest *Obolus* (*Westonia*) *ella* (Hall and Whitfield) (Pl. XLVII) and there is a trace of the surface of the latter. A closer comparison of the two shows that *O.* (*W.*) *ella* is a broader shell, with a characteristic surface ornamentation. *Lingulella mosia* may be the Upper Cambrian representative of the Middle Cambrian *Obolus* (*Westonia*) *ella*.

Formation and locality.—**Lower Ordovician:** (**364a** [Sardeson, 1896, p. 95]) reported by Sardeson from the Oneota dolomite along St. Croix River in both Wisconsin and Minnesota.

Upper Cambrian: (**113**) "St. Croix sandstone" at La Grange Mountain (or Barn Bluff), near Red Wing, Goodhue County, Minnesota.

(**78** and **78s**)[a] "St. Croix sandstone," quarry near St. Croix River in suburbs of Osceola, Polk County; (**85**)[b] "*St. Croix sandstone*" *near Prairie du Sac, Sauk County;* (**85x** and **S85x**) upper beds of the "St. Croix sandstone" near Mazomanie, Dane County; (**99a**) "St. Croix sandstone" near Pilot Knob, Adams County; (**100**) "St. Croix sandstone" near Menomonie, Dunn County; (**79** and **79s**) "St. Croix sandstone" near Hudson, St. Croix County; (**98x**) "St. Croix sandstone" near Eau Claire, Eau Claire County; (**78b**) "St. Croix sandstone" 50 feet (15.2 m.) above St. Croix River, near the landing at Osceola, Polk County; (**98a**) "St. Croix sandstone" at Marine Mills, Washington County; (**86**) "St. Croix sandstone," at Van Ness's quarry, Gibraltar Bluff, Lodi, Columbia County; and (**85s**) "St. Croix sandstone" at Prairie du Sac, Sauk County; all in Wisconsin.

(**364**) St. Lawrence formation of Sardeson [1896, p. 95], in both Wisconsin and Minnesota.

(**341a**) Sandstone at McGregor, Clayton County, Iowa.

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[a] The species also occurs in Locality **78c** (p. 214).

[b] **85** is the type locality, though the specimens in the United States National Museum collections to which that number is assigned were collected later than the type specimens.

Lingulella mosia osceola (Walcott).

Plate XVIII, figures 2, 2a–c.

Obolus (Lingulella) mosia osceola Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 409. (Characterized as below as a new variety.)

There is a considerable variation in the form of *Lingulella mosia* (Hall) as it occurs in the brown sandstone of Osceola, and for the narrow, more elongate variety the name *osceola* was proposed [Walcott, 1898b, p. 409]. It is an intermediate form between *L. mosia* and *L. perattenuata* (Whitfield) (Pl. XXI). The same, or a closely allied, variety occurs in a light-colored sandstone at Eau Claire.

The varietal name is derived from Osceola, the type locality.

Formation and locality.—**Upper Cambrian**: (78 and 78s)[a] *"St. Croix sandstone" in quarry near St. Croix River, in suburbs of Osceola, Polk County*, and (98) "St. Croix sandstone" near Eau Claire, Eau Claire County; both in Wisconsin.

Lingulella nanno (Walcott).

Plate XXIV, figures 1, 1a–d.

Obolus (Lingulella) nanno Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 409. (Described as below as a new species.)

Shell very small; general form elongate ovate, with the ventral valve subacuminate to acuminate, and the dorsal valve elongate in outline. The convexity of the two valves is moderate in the very small shells, increasing slightly with the increase in size. Average length of the ventral valve is about 2 mm., and that of the dorsal valve a little less.

The surface of the shell as it appears in the hard, fine grained, drab-colored limestone is marked by fine, concentric striæ, and very faint traces of radiating striæ.

Observations.—This minute species occurs in thin layers of limestone interbedded in the Conasauga ("Coosa") shale. Its small size and acuminate ventral valve distinguish it from other species. It is associated with *Dicellomus appalachia* Walcott and fragments of trilobites.

Formation and locality.—**Middle Cambrian**: (16) *Conasauga limestone, Blountsville Valley, Blount County;* and (91) Conasauga ("Coosa") shale at Cedar Bluff, Cherokee County; both in Alabama.

Lingulella nathorsti Linnarsson.

Plate XXXI, figures 1, 1a–h.

Lingulella ? nathorsti Linnarsson, 1876, Bihang till K. svensk. Vet.-Akad. Handl., Bd. 3, No. 12, pp. 15–16, Pl. III, figs. 24–30. (Described and discussed in English as a new species.)

This is a medium-sized well-characterized species. As the illustrations of Linnarsson [1876, Pl. III] are not altogether satisfactory I have had several drawings made from material received from Dr. G. Lindström.

Plate XXXI, figures 1, 1a–b, represents specimens from the gray, arenaceous, shaly sandstones at Andrarum, and Plate XXXI, figures 1c–e, specimens from the hard, dark-gray sandstones in Dalarne. Specimens from the dark sandstone show the surface of the shell to have been marked by concentric striæ and lines of growth and very fine radiating striæ. The casts from the arenaceous shales show the area of the valves (Pl. XXXI, figs. 1 and 1b) and traces of the vascular markings.

Observations.—In form and outline *Lingulella nathorsti* may be compared with *L. radula* Matthew, but it differs greatly from that species in its surface characters.

The specific name was given in honor of Mr. A. G. Nathorst.

Formation and locality.—**Lower Cambrian**: (320x) *In strata with Holmia kjerulfi at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad;* and (8y) with *Torellella lævigata* in the "Sparagmite" sandstone, at Skårösen, northwest Dalarne, Province of Kopparberg; both in Sweden.

[a] 78 is the type locality.

Lingulella nicholsoni Callaway.

Plate XXX, figures 3, 3a–f.

Lingulella nicholsoni Callaway, 1874, Quart. Jour. Geol. Soc. London, vol. 30, p. 196. (Name proposed.)
Lingulella nicholsoni Callaway, 1877, idem, vol. 33, pp. 668–669, Pl. XXIV, figs. 11, 11a–b. (Described and discussed as below. Figs. 11 and 11b are reproduced in this monograph, Pl. XXX, figs. 3 and 3a, respectively.)
Lingulella nicholsoni Callaway, Davidson, 1883, British Fossil Brachiopoda, vol. 5, pt. 2, pp. 208–209, Pl. XVII, figs. 31, 31a, and 32. (The discussion of the species, the localities, and the figures given in the preceding reference are here copied.)
Lingulella nicholsoni Callaway?, Matley, 1902, Quart. Jour. Geol. Soc. London, vol. 58, pt. 1, p. 141. (A new locality mentioned.)

The original description by Callaway follows:

Ovate, depressed, widest about the middle, two-thirds as broad as long, front and sides rounded, beak moderately acuminate, area of ventral valve striated, the striæ parallel to the external slope of the valve, pedicle groove divided by a narrow ridge down the middle; visceral surface pitted; exterior surface marked by fine concentric lines of growth. Length, 5 lines; width, 3.5 lines.

This is a larger shell than *Lingulella ferruginea* Salter and its sides are not so parallel. It closely resembles *L. lepis* (Salter); but *L. lepis* is wider toward the front, according to Davidson's figures [1883, Pl. XVII, figs. 31, 31a, and 32].

In a collection kindly lent to me by Dr. Charles Lapworth I found this species to vary greatly in outline in the shales. It is a well-marked species. Plate XXX, figures 3b and 3c, shows probably the most characteristic adult forms.

The specific name was given in honor of Mr. Nicholson.

Formation and locality.—**Upper Cambrian:** (**304i** [*Callaway, 1877, p. 669*]) *Shineton shales at Shineton, Mary Dingle, Dryton, Cressage, 1 mile (1.6 km.) west of Cressage, west of Harley, and under Cound-Moor quarry;* and (**304k** [Davidson, 1883, pp. 208 and 209]) Shineton shales at Bull Hill Cottage and Pewardine; all in South Shropshire, England.

(**304l**) In the collection received from Dr. Charles Lapworth, collected by R. R. Rhodes, of the Geological Survey of Great Britain, the species is recorded in shales at the following localities: 2246, 2481, 2499, 2512, 2513, 2541, 2548, 2556, 2567, 2625, and 2627, all on Shineton Brook and vicinity, South Shropshire, England.

(**304a** [Groom, 1902, p. 110]) "Bronsil shales;" and (**304b** [Groom, 1902, p. 109]) lower part of the "White Leaved Oak shales" (the zone of *Polyphyma*); both in the Malvern Hills, between Herefordshire and Worcestershire, England.

Lingulella ora (Walcott).

Plate XXXV, fignres 9, 9a–d.

Obolus (Lingulella) orus Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 330. (Characterized as below as a new species.)

This is a shell of the *Lingulella manticula* (White) form, but differs from it in being more elongate; ventral valve more acuminate and dorsal valve proportionately larger. Its nearest allies in form are among the group of narrow, elongate shells occurring in New Brunswick and Cape Breton. It differs from all of them—*Lingulella collicia* (Matthew), *L. flumenis* (Matthew), *L. cania* (Walcott), etc.—in having a thick, strong shell and usually more acuminate dorsal valve. The exterior surface bears rather strong concentric lines of growth and very fine, irregular, undulating, elevated striæ that suggest the surface of *Obolus (Westonia) ella* (Hall and Whitfield) when seen in reflected light with a strong magnifier.

This little shell occurs abundantly, but good interiors have not been found. The main vascular sinuses appear to be submarginal in both valves, and the visceral area of the dorsal valve narrow, extending a little beyond the center of the valve.

Formation and locality.—**Upper Cambrian:** (**9p**) *About 160 feet (48.8 m.) above the porphyry contact in the limestones of the Reagan sandstone, in SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W.;* and (**9q**) about 10 feet (3 m.) above the porphyry contact and 90 feet (27.4 m.) below the Arbuckle limestone, in limestones of the Reagan sandstone, in middle of west half of sec. 2, T. 4 N., R. 13 W.; both about 15 miles (24.2 km.) northwest of Fort Sill, Comanche County, Oklahoma.

A single specimen of a ventral valve 4 mm. in length that is much like the corresponding valve of *Lingulella ora* occurs at the following locality. More and better material is needed before an identification can be made that is more than tentative.

Middle Cambrian: (11m) Drill cores of limestone in the Bonneterre limestone at horizons 10 and 20 feet (3 and 6 m.) above the Lamotte sandstone at Flat River, St. Francois County, Missouri.

Lingulella oweni (Walcott).

Plate XVIII, figures 5, 5a–f.

Obolus (*Lingulella*) *oweni* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 410. (Described and discussed essentially as below as a new species.)

General form ovate, with the ventral valve obtusely acuminate, and the dorsal valve more broadly rounded posteriorly; valves appear to have been moderately convex, as far as can be determined from the flattened specimen in the shaly sandstones. Surface of shell marked by concentric lines and striæ of growth and indistinct, radiating striæ. There are no traces of the interior markings observed. The shell is of medium thickness; none of the specimens show how it was built up, farther than that there were oblique lamellæ attached to the outer layer in the anterior portion of the valve. The largest ventral valve from Gibraltar Bluff has a length of 16.5 mm.; width, about 12 mm.; an associated dorsal valve 14 mm. in length, has a width of 11 mm. as it occurs flattened on the surface of the sandstone. A smaller shell referred to this species from Osceola averages from 6 to 8 mm. in length.

As shown in the cast of an interior of a shell, the area is rather long, and divided midway by a sharp pedicle furrow; the flexure lines are situated about midway between the cast of the pedicle furrow and the lateral margin. The area formed a thin shelf between the pedicle groove and the lateral margins, the undercut extending far back under the area; a broken portion of this is preserved on the cast illustrated by figure 5a.

One cast of the interior of a ventral valve shows a slight trace of the visceral area (Pl. XVIII, fig. 5d). In a cast of a dorsal valve (fig. 5b) both the central and anterior lateral muscle scars are somewhat indistinctly preserved.

Observations.—This species is most nearly related to *Lingulella ampla* (Owen). It differs, as far as can be determined from the material for comparison, in being less elongate and in the position of the central and anterior lateral muscle scars in the dorsal valve, as may be seen by comparing Plate XVIII, figure 5b, with Plate XXVIII, figure 1g. The typical form of this species is represented on Plate XVIII, figures 5, 5b, and 5c, and a smaller form, which has been referred to it, by figures 5d, 5e, and 5f.

The species differs strongly from *Obolus* (*Westonia*) *stoneanus* (Whitfield) in its surface markings, although the outline of the valves is almost the same in the two species.

The specific name was given in honor of Dr. D. D. Owen.

Formation and locality.—**Upper Cambrian**: (78c) "St. Croix sandstone" at Osceola, Polk County; (86) "*St. Croix sandstone*" *at Van Ness's quarry, Gibraltar Bluff, Lodi, Columbia County;* (85z) "St. Croix sandstone" at Madison, Dane County; (85a) "St. Croix sandstone" at Brown's quarry, Prairie du Sac, Sauk County; and (85s) "St. Croix sandstone" at Prairie du Sac, Sauk County; all in Wisconsin.

(97) "St. Croix sandstone" at Reads Landing, foot of Lake Pepin, Wabasha County, Minnesota.

Lingulella perattenuata (Whitfield).

Plate XXI, figures 1, 1a–i.

Lingulepis perattenuatus Whitfield, 1877, U. S. Geog. and Geol. Survey Rocky Mtn. Region, Rept. Geol. Black Hills of Dakota, Prelim. Rept., p. 9. (Described and discussed as on p. 524 as a new species.)

Lingulepis perattenuatus Whitfield, 1880, U. S. Geog. and Geol. Survey Rocky Mtn. Region, Rept. Geol. and Resources Black Hills of Dakota, by Newton and Jenney, p. 337, Pl. II, figs. 7–9. (Copy of preceding reference. The specimens represented by figures 7, 8, and 9 are redrawn in this monograph, Pl. XXI, figs. 1i, 1h, and 1b, respectively.)

Lingulepis cuneolus SCHUCHERT (in part) [not WHITFIELD], 1897, Bull. U. S. Geol. Survey No. 87, p. 259. (Merely refers Whitfield's *Lingulepis perattenuatus* to *L. cuneolus.*)

Obolus (*Lingulella*) *perattenuatus* (Whitfield), WALCOTT, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, p. 443. (Merely changes generic reference.)

The original description by Whitfield follows:

Shell spatulate or elongate-ovate, becoming acutely pointed toward the beak; sides below the middle of the length of the ventral valve rounded; front margin very regularly curved; cardinal slopes straight, or sometimes slightly convex; greatest width a little more than half the length of the ventral valve and sometimes nearly two-thirds as great. Surface of the ventral valve depressed convex, very slightly subangular along the middle above the lower third of the length, and a little more distinctly so in the upper part. Apex scarcely truncate. Dorsal valve considerably shorter than the ventral, broadly truncated at the upper end, the line of truncation being distinctly arched. Surface evenly convex. Structure of the surface of the shell polished, with fine, somewhat lamellose lines of growth.

The material studied by Whitfield, now in the collections of the United States National Museum, has been carefully worked over and the cardinal area of both valves developed in the casts of the interior of the shell (Pl. XXI, figs. 1 and 1d). The plane of the area of the ventral valve coincides near its edges with the edge of the shell, but it rises quite rapidly toward the pedicle furrow. It is divided at the center by a rather deep, strongly marked pedicle furrow and near the lateral margin by a rather sharp, very narrow flexure line (Pl. XXI, figs. 1a and 1c). The striæ of growth cross the area parallel with its base. They are sharp and crowded on the lateral slopes, but are very indistinctly preserved in the pedicle groove. The area of the dorsal valve is lower than that of the ventral and, in the typical specimens, shows nothing more than the fine striæ of growth (Pl. XXI, fig. 1i).

No traces of muscle scars or vascular markings have been found in the material from the type locality in the Black Hills, but, in some casts of the interiors of valves from Texas, traces of the visceral cavity and muscle scars are shown. In Plate XXI, figure 1e, the outline of the visceral cavity (v) is preserved, also the main vascular sinus (vs).

Both valves of the shell are much thinner than in *Lingulella acutangula* (Roemer). The shell is formed of a thin outer layer and one or two inner layers or lamellæ, which occur in the posterior half of the shell. The surface of the outer layer is marked by concentric striæ and lines of growth and very fine, more or less interrupted radiating striæ. The inner layer is characterized on its outer surface by fine, concentric, radiating striæ. A few minute punctæ occur on the inner surface of several shells, as shown by the papillæ on the cast.

Observations.—The most nearly related species in the American Cambrian rocks is *L. acutangula* (Roemer). It differs in having a much thinner shell, and, as far as they are preserved, in the character and position of the interior markings and muscle scars.

The type species was described from the "Potsdam formation" of the Black Hills. From a recent study of the Black Hills Cambrian section I have found that it is from the Middle Cambrian sandstones and limestones as they occur near the headwaters of Red Canyon Creek and in the vicinity of Deadwood. It is also identified from the Middle Cambrian of central Texas and in the same fauna from the "Tonto" sandstone of the Grand Canyon of the Colorado, Arizona. In the Black Hills it is associated with *Lingulella* (*Lingulepis*) *acuminata* (Conrad) and *Dicellomus politus* (Hall).

FORMATION AND LOCALITY.—**Upper Cambrian:** (**67c**) Sandstone on Tatur Hill, 7 miles (11.2 km.) northwest of Burnet, Burnet County; (**70**) limestone near Morgans Creek, Burnet County; and (**68y**) interbedded sandstone and limestone on Packsaddle Mountain, Llano County; all in Texas.

Middle Cambrian: (**355**) *Sandstones on Red Canyon Creek, southwest side of Black Hills;* and (**355f**) sandstones near Deadwood, Black Hills; both in South Dakota.

(**74**) Sandstone about 300 feet (91.4 m.) above the base of the Tonto group, at the head of Nunkoweap Valley; and (**74d**) sandstone beds in the "Tonto" shale just above massive sandstones near the mouth of Bass Canyon, on the south side of the Grand Canyon of the Colorado, southeast of Powells Plateau; both in the Grand Canyon of the Colorado, Arizona.

A single ventral valve of this species, or a closely related form, occurs in the following locality:

Middle Cambrian: (**90**) Siliceous limestone about 15 feet (4.6 m.) above the Coronado quartzite [Lindgren, 1905, p. 3], 0.5 mile (0.8 km.) southwest of Milk ranch, on the first spur north of the one which the main road follows, Clifton quadrangle (U. S. Geol. Survey), Graham County, Arizona.

Lingulella phaon (Walcott).

Plate XXVI, figures 1, 1a–e.

Obolus (*Lingulella*) *phaon* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 410–411. (Described and discussed essentially as below as a new species.)

General form ovate, with the ventral valve subacuminate, and the dorsal broadly ovate; valves of moderate convexity. Surface of the shell marked by fine concentric lines and striæ of growth, and very fine more or less interrupted radiating striæ; when the outer layer is exfoliated the inner surface is marked by numerous fine radiating striæ; the interior surface as seen in casts is more or less marked by rather large papillæ arranged in concentric lines, the papillæ corresponding to the pits or punctæ on the inner surface of the shell. The shell is rather thick, and is built up of a thin outer layer and several inner layers or lamellæ, the lamellæ toward the front being oblique to the outer layer. A large ventral valve 15 mm. in length has a width of 13 mm.; a dorsal valve 11 mm. long has a width of 10 mm.

As shown in the cast of the interior of the shell, the area of the ventral valve rises gradually from the margin toward the pedicle groove. It is broken midway by the cast of a strong pedicle furrow and a little more than halfway up toward the lateral margin by a strong flexure line; the striæ of growth are very fine and cross the area parallel with its base. The cast of the undercut shows that the area formed a thin shelf between the pedicle groove and the lateral margins. The area of the dorsal valve is well defined. As in the ventral valve the area formed a thin shelf, as shown by the cast of the undercut extending well over the area in several of the specimens; the cast of the broken edges of the undercut between the areas is shown by Plate XXVI, figures 1b, 1c, 1d.

The cast of the interior of the ventral valve (Pl. XXVI, figs. 1b and 1c) shows the strongly defined, narrow, visceral area (v), the trapezoidal area (c) in which the central, middle, and outside lateral muscle scars occur, also the anterior lateral muscle scars (j), and unusually strong main vascular sinuses (vs). In a specimen which is not illustrated, apparent lines of growth occur on the ridge in front of the trapezoidal area (c), a feature that is present in *L. hayesi* (Walcott) and *Obolus matinalis* (Hall). In a dorsal valve the relatively narrow central vascular area extends forward nearly to the center of the shell (Pl. XXVI, fig. 1d); central (h) and anterior lateral (j) scars are faintly indicated, also transmedian (i) scars, and the median septum (s); the main vascular sinuses (vs) are unusually deep and well defined.

Observations.—This species at first inspection might be taken for *Lingulella ampla* (Owen) (Pl. XXVIII). It occurs at the same horizon in association with *Dicellomus politus* (Hall). It differs in having a broader and less elongate shell, with the visceral area of the dorsal valve terminating near the center instead of forward of the center, and, as far as can be determined from the material at hand, in having a thicker shell. It also averages about one-fourth less in size.

Formation and locality.—**Upper Cambrian**: (**98** and **98x**)[a] "*St. Croix sandstone*" *near Eau Claire, Eau Claire County*; and (**82a**) "St. Croix sandstone" 25 feet (7.6 m.) above the water level near the Knapp, Stout and Company's buildings, Menomonie, Dunn County; both in Wisconsin.

(**84a**) "St. Croix sandstone" at River Junction, Houston County, 20 miles (32.2 km.) below Dresbach, Minnesota.

Lingulella pogonipensis (Walcott).

Plate XX, figures 3, 3a–c.

Obolus (*Lingulella*) *pogonipensis* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 411–412. (Described and discussed as below as a new species.)

Shell rather large, general form ovate, almost ovate cuneate in the ventral valve; dorsal valve more ovate. Valves moderately convex. Surface of the shell marked by numerous concentric lines and striæ of growth, and very fine radiating striæ; the finer concentric striæ are slightly irregular, but not nearly so much so as in many species of the genus. The outer

[a] **98x** is the type locality.

surface of the inner layer is marked by very fine radiating striæ, also concentric lines of growth. The shell is below the average thickness and is formed of a thin outer layer and one or more inner layers or lamellæ.

The largest ventral valve has a length of 15 mm.; width, 11 mm. As shown by a partial cast the area is of medium length, and divided midway by a narrow, strongly marked cast of the pedicle furrow.

Observations.—In form the valves of this species somewhat resemble those of *Lingulella ampla* (Owen) (Pl. XXVIII), and more closely those of *L. isse* (Walcott) (Pl. XXXIX). In the absence of all interior markings no further comparisons can be made.

The species derives its specific name from its occurrence in the Pogonip limestone.

Formation and locality.—**Passage beds** between the Upper Cambrian and the Ordovician: (**201**) *Arenaceous Pogonip limestone, on east slope of ridge east of Hamburg Ridge;* (**205**) siliceous limestone on Roundtop Mountain; (**203a**) limestones at base of Pogonip limestone, in the spur on Hamburg Ridge extending out southwest from Wood Cone; and (**211**) siliceous Pogonip limestone, on spur of Hamburg Ridge extending southwest from Wood Cone; all in the Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

Specimens somewhat doubtfully referred to this species occur at the following localities:

Upper Cambrian: (**32f**) Thin-bedded siliceous limestones near the top of the Upper Cambrian, about 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range, Tooele County, Utah.

Upper? Cambrian: (**358a**) Siliceous limestone in Pinal County, Arizona.

Lingulella prima (Conrad MS.) (Hall).

Plate XXVII, figures 1, 1a–c.

Lingula ovata Emmons [not McCoy], 1842, Nat. Hist. New York, Geology, pt. 2, p. 105. (Mentioned.)

Lingula prima (Conrad MS.) Hall, 1847, Nat. Hist. New York, Paleontology, vol. 1, p. 3, Pl. I, fig. 2. (Described and discussed. It is the first description of the fossil, though no reference is made to the fact that it is a new species.)

Lingula prima Hall, Emmons, 1855, American Geology, vol. 1, pt. 2, p. 202. (Described.)

Lingulepis prima (Hall), Miller, 1877, American Paleozoic Fossils, Catalogue, p. 115. (Merely changes generic reference.)

Obolella prima (Hall), Whitfield, 1884, Bull. Am. Mus. Nat. Hist., vol. 1, No. 5, pp. 142–143, Pl. XIV, figs. 3–5. (Discussed.)

Lingulella? prima (Hall), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 69, footnote. (Discussed.)

Lingulepis prima (Hall), Schuchert (in part), 1897, Bull. U. S. Geol. Survey No. 87, p. 260. (Merely changes generic reference. Includes species other than Hall's "*Lingula prima.*")

Obolus (*Lingulepis*) *primus* (Hall), Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 673. (Merely changes generic reference.)

General form subovate with the ventral valve subacuminate and the dorsal valve broadly subacuminate. There is a tendency in some individuals to a subcuneate outline. Valves moderately convex, increasing in some shells to almost strongly convex. There is some range of variation in the outlines of the valves, as shown by Plate XXVII, figures 1 and 1a. The surface of the shell is marked by concentric lines and small undulations of growth and by very fine radiating striæ. When the outer layer is exfoliated the inner layer is seen to be marked by sharp radiating striæ and a few concentric lines of growth. The interior surface shows fine radiating striæ and a few scattered pits. The shell is of medium thickness and formed of a thin outer layer and several inner layers, or lamellæ, which are more or less oblique to the outer layer; the lamellæ are much more numerous toward the margins and form a rather thick rim around the anterior and anterolateral margins. The average length of the ventral valve is 5 mm., width 4 mm. The dorsal valve is slightly shorter in proportion to its width.

As shown in the interior casts the area of the ventral valve is relatively short; it is divided at the center by a rather strongly marked pedicle furrow and well out toward its margins by clearly defined flexure lines. Faint traces of striæ of growth cross the area parallel with its base; the area of the dorsal is not shown in any of the specimens in the collection.

The cast of the interior of the ventral valve shows the visceral cavity (v), the trapezoidal area (c), and the rather strong median ridge, which extends from the area forward to the anterior

margin of the visceral area. This ridge corresponds to a median groove passing anteriorly into the heart-shaped cavity. There are no clearly defined muscle scars in any specimen in the collection, although the trapezoidal area in the ventral valve, in which the central, middle, and outside lateral muscle scars usually occur, is fairly well preserved in one specimen. None of the casts of the dorsal valve show more than the cast of the median ridge or septum. Of the markings left on the shell by the vascular system only the main vascular sinuses have been preserved on the cast of the ventral valve.

Observations.—This is a small but striking species that occurs in the sandstones east of the Adirondack Mountains. In outline and form it may be grouped with *Lingulella ferruginea* Salter and *L. bellula* (Walcott) (Pl. XIX). It is a larger and more acuminate shell than *L. ferruginea*, and its dorsal valve is distinguished from that of *L. bellula* by being shorter and broader anteriorly. It occurs quite abundantly in the thin beds of hard sandstones at Ausable Chasm, below Keeseville, Essex County, New York, associated with *Ptychoparia minuta* and *L.* (*Lingulepis*) *acuminata* (Conrad)(?). The interior of the ventral valve resembles typical forms of *Obolus* more nearly than the typical forms of *Lingulella*. This may be due to the state of preservation or it may be that, despite the *Lingula*-like outlines of the valves, it is more a true *Obolus* in its interior markings as these are developed in *O. matinalis* (Hall). (Compare Pl. VIII, fig. 1e, with Pl. XXVII, fig. 1.)

Whitfield [1884, p. 142] referred the species to the genus *Obolella*. There is a strong resemblance between the dorsal valve of the species and that of some of the species of *Obolella*, but a careful study of a large amount of material shows that this resemblance is confined to the dorsal valve. He also refers "*Obolella nitida*" Ford to this species, but "*O. nitida*" is a true *Acrotreta* and occurs in the lower portion of the *Olenellus* fauna of the Lower Cambrian, and *Lingulella prima* (Hall) is from the Upper Cambrian.

Dwight [1886, p. 208] mentions "*Obolella* (*Lingulella*) *prima*" as occurring in "Potsdam" strata at Poughkeepsie, New York, but inasmuch as he does not describe the specimen, and the form has not been found in other extensive collections that have been made there, the reference is considered as exceedingly doubtful. I think Dwight had small specimens of the dorsal valve of *Lingulella* (*Lingulepis*) *acuminata* (Conrad), which occurs at the locality at Poughkeepsie.

Formation and locality.—**Upper Cambrian**: (**77**)[a] *Sandstone near the water below the falls at the high bridge, and also at several horizons in the section, the highest point being 70 to 75 feet (21 to 23 m.) above the water, in Ausable Chasm;* (**367f**) sandstone at French Creek, 1 mile (1.6 km.) east of Keeseville; (**367g**) sandstone in the bed of the brook, in the suburbs of Port Henry; (**367h**) Rosses Bridge, 4 miles (6.4 km.) west of Essex; (**136**) Potsdam sandstone in bank of stream opposite the first switch on the Port Henry and Maine Railroad out of Port Henry; and (**338t**) Potsdam sandstone in Ausable Chasm, below Keeseville; all in Essex County, New York.

Lingulella? primæva Hicks.

Plate XXXI, figures 5, 5a.

Lingulella primæva Hicks, 1871, Quart. Jour. Geol. Soc. London, vol. 27, p. 401, Pl. XV, figs. 13 and 14. (Described as a new species.)

Lingulella primæva Hicks, Salter and Etheridge, 1881, Mem. Geol. Survey Great Britain, vol. 3, 2d ed., p. 538. (Localities mentioned.)

Lingulella primæva Hicks, 1881, Popular Science Review, new ser., vol. 5, p. 297. (Mentioned only.)

Lingulella primæva Hicks, Davidson, 1883, British Fossil Brachiopoda, vol. 5, pt. 2, p. 208, Pl. XVII, figs. 33 and 34. (Described and discussed. Fig. 33 is drawn from the specimen figured by Hicks, 1871, Pl. XV, fig. 14. Figs. 33 and 34 are reproduced in this monograph, Pl. XXXI, figs. 5a and 5, respectively.)

This species is rather doubtful, owing to its condition of preservation, which renders it quite difficult to make any comparison with other described species. It occurs in association with *L. ferruginea* Salter, but is a much larger species.

Formation and locality.—**Middle? Cambrian**: (**366c**) "*Caerfai group*" [*Salter and Etheridge, 1881, p. 538*] *at Caerfai, Nuns Hill, and Porthclais Harbor, all south of St. Davids;* and (**318i**) red shales of the Caerfai group at St. Davids; both in South Wales.

[a] 77 is the type locality, though the specimens in the United States National Museum collections to which that number is assigned were collected later than the type specimens.

Lingulella punctata (Walcott).

Plate XX, figures 6, 6a.

Lingula? manticula Walcott [not White], 1884, Mon. U. S. Geol. Survey, vol. 8, pp. 13–14, Pl. IX, fig. 3, and Pl. XI, fig. 2. (Discussed. The specimens represented by Pl. IX, fig. 3, and Pl. XI, fig. 2, are redrawn in this monograph, Pl. XX, figs. 6 and 6a, respectively.)

Obolus (*Lingulella*) *punctatus* Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 412–413. (Described as below as a new species.)

General form ovate, with the ventral valve subacuminate. Valves moderately convex, with the dorsal valve having a slightly depressed median sinus that extends from near the umbo to the anterior margin. Surface of shell marked by lines and striæ of growth, and very fine, slightly undulating striæ; also a few faintly indicated radiating striæ; when the outer layer is exfoliated the outer surface of the inner layer is seen to be marked by numerous and very fine radiating striæ, in addition to the concentric lines of growth; the interior of the shell, as shown by the casts, was strongly pitted or punctate, the punctæ being arranged in concentric lines following the lines of growth. The shell is relatively thin and formed of a thin outer layer and one or more thin inner layers or lamellæ.

The type specimen of the ventral valve has a length of 9 mm., width 6.5 mm. An associated dorsal valve has a length of 7 mm., width 5.5 mm.

The only interior that shows anything more than the punctate surface is that of the dorsal valve. In this the area is partly shown; it is relatively short and marked by fine striæ parallel to its base, and two imperfectly developed flexure lines. The cast of a narrow median septum is well shown, and on each side of it the middle lateral muscle scars. The path of advance of the central muscle scars is quite plain, also one of the scars. The only trace of the vascular system is a portion of a main vascular sinus.

This form owes its specific name to the concentrically punctate interior of the shell.

Formation and locality.—**Upper Cambrian:** (3i) Limestone at summit of canyon, 10 miles (16.1 km.) south of Egan Canyon, east side of Egan Range, White Pine County; (8o) limestone on the slope of the ridge where the range swings around to the northwest, 2 miles (3.2 km.) north of Aurum, Schell Creek Range, White Pine County; (61) limestone in the Dunderberg shale [Walcott, 1908f, p. 184], a little south of the Hamburg mine, Eureka district [Hague, 1892, Atlas], Eureka County; and (62) limestone in the Dunderberg shale [Walcott, 1908f, p. 184], in canyon immediately north of Adams Hill, Eureka district [Hague, 1892, Atlas], Eureka County; all in Nevada.

Middle Cambrian: (7i) Limestone just west of the summit on the road east of Schellbourne, Schell Creek Range, White Pine County, Nevada.

(54) Eldorado limestone [Walcott, 1908f, p. 184], on east slope of Prospect Mountain, in New York Canyon; (57) shaly limestone in the Eldorado limestone [Walcott, 1908f, p. 184], at the 700-foot (213.4 m.) level in the Richmond mine, Ruby Hill [Hague, 1892, p. 43, and Pl. I, opposite p. 116]; and (58) *shaly limestone in upper beds of Secret Canyon shale, east side of New York and Secret canyons;* all in the Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

Lingulella quadrilateralis (Walcott).

Plate XXXIX, figures 6, 6a.

Obolus (*Lingulella*) *quadrilateralis* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 331. (Described and discussed as below as a new species.)

General form rounded, quadrilateral; valves moderately convex. Surface marked by concentric lines and ridges of growth with fine striæ between. The surface of the inner layers of the shell is shiny and marked by fine radiating striæ in addition to the concentric lines. The shell is rather thin; it is built up of several layers.

Observations.—This species differs from other described species by its subquadrilateral outline. In this respect it may be compared with *Obolus* (*Westonia*) *chuarensis* (Walcott) (Pl. XXV), from which it differs in having a thinner shell and different surface markings.

Formation and locality.—**Middle Cambrian:** (91) *Conasauga ("Coosa") shale, at Cedar Bluff, Cherokee County;* and (56q) limestone at the very top of the Conasauga limestone, in quarry at Ketona, about 5 miles (8 km.) northeast of Birmingham, Jefferson County; both in Alabama.

(140a) Shales 200 yards (182.9 m.) east of Thomas Mills, 5 miles (8 km.) north of Cave Spring, Floyd County, Georgia.

Lingulella radula Matthew.

Plate XLV, figures 1, 1a–l.

Lingulella radula Matthew, 1891, Trans. Roy. Soc. Canada, 1st ser., vol. 8, sec. 4, No. 6, pp. 147–148, Pl. XV, figs. 7a–b and 8a–e. (Described and discussed as a new species. Pl. XLV, figs. 1, 1a, 1b, 1c, and 1e, are drawn from specimens in Matthew's type material, but further identification is impossible.)

Lingulella radula aspera Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 204–205, Pl. XV, figs. 2a–d. (Described and discussed as a new variety.)

General form ovate cuneate, with the ventral valve subacuminate and the dorsal valve broadly ovate in outline; valves apparently moderately convex, but this is uncertain, as the shells have all been compressed in the arenaceous shale. Surface marked by concentric lines of growth and very fine, irregular striæ. It is the type of surface of *Obolus* (*Westonia*) *ella* (Hall and Whitfield) or *Lingulella* (*Lingulepis*) *gregwa* (Matthew), reduced so that the surface, under a strong magnifier, has a roughened or minutely papillose appearance. Matthew [1891, p. 148] describes it as due to wavy squamose ridgelets having the edges and points directed forward, as in *Botsfordia pulchra* (Matthew). Owing to this roughened surface the outer layer of the shell usually adheres to the matrix, leaving the dark, shiny surface of the inner layer. The inner surface is marked by concentric rows of punctæ and fine radiating striæ. The shell is of medium thickness and formed of a thin outer layer and several inner layers or lamellæ, which are more or less oblique to the outer layer on the anterior half of the shell, One of the largest ventral valves has a length of 10 mm., width 8 mm.; a large dorsal valve has a length of 9 mm., width 8 mm.

The cardinal area and pedicle groove are usually obscured by the adhering fragments of shell. The pedicle groove is strong and narrows gradually as it crosses the long area of the ventral valve. The area of the dorsal valve is short and broad.

The cast of the visceral cavity (v) is preserved in a number of specimens. In Plate XLV, figures 1 and 1i, the heart-shaped pit (x), so characteristic of *Obolus* and of *Lingulella acutangula* (Roemer), is clearly outlined. A narrow median septum (s) is found in the dorsal valve (Pl. XLV, figs. 1j and 1l), and the anterior lateral muscle scars (j, fig. 1i) are clearly shown in the ventral valve. The centrals, middle laterals, and outside laterals can not be differentiated in the trapezoidal area (c) in front of the heart-shaped pit. On the dorsal valve the centrals (h, figs. 1d, 1j, and 1l) and anterior laterals (j, fig. 1j) are finely preserved.

Considerable portions of the markings of the vascular system are preserved on the casts of the interior of the valves. The main vascular trunks of the ventral valve are shown by figures 1, 1a, and 1c, and the position of the parietal scar is also seen at ps (figs. 1a, 1c, and 1i).

Observations.—Doctor Matthew sent me the types of this species for study and illustration. I have not been able to interpret some of the interior markings in the manner that his figures indicate, but this is not unexpected when the obscure character of most of the specimens is considered. When at St. John, in 1877, I collected a large number of specimens of this species, and, as they are somewhat better preserved than the types, drawings have been made of the casts of the interiors of three ventral valves and one dorsal valve.

The variety, spoken of by Matthew [1903, p. 204], from the lower portion of Division 2c shows the outer surface unusually well preserved, but I do not think it is a distinct species or worthy of a varietal name. In the collections made by Loper on McPhees Brook, Division 2 of Matthew's section, there are small specimens that correspond to Matthew's variety *aspera* collected on McNeil Brook; also adult specimens. The horizon is much lower, according to Matthew's sections, but the specimens are very much alike from the two localities.

Formation and locality.—**Middle Cambrian:** (**301y**) *Shaly sandstones of Division C2c of Matthew, east side of Courtney Bay, St. John;* and (**301x**) sandstones of Division C2c of Matthew, in the city of St. John; both [Matthew, 1891, p. 148] in New Brunswick.

(**307c** [Matthew, 1903, p. 205]) Sandstones probably belonging with Division C2c of Matthew, on Mira River; and (**307b**) sandstone on McPhees Brook; both in eastern Cape Breton, Nova Scotia, Canada.

Lingulella randomensis (Walcott).

Plate XXI, figures 5, 5a.

Obolus (*Lingulella*) *randomensis* Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 688–689. (Described and discussed as below as a new species.)

General form elongate ovate; ventral valve rather broadly subacuminate, and the dorsal valve slightly acuminate. The widest portion of the valves is the anterior third, from which they very gradually narrow toward the cardinal slopes. The convexity of the valves is moderate and uniform and nearly the same in each. Surface of the shell marked by fine concentric striæ, and rather strong lines of growth, also fine radiating striæ. The shell is formed of a few thin lamellæ or layers, as far as can be determined from the fragments preserved on the casts in the sandstone. The longest ventral valve in the collection has a length of 10 mm. with a maximum width of 6 mm. The dorsal valve is slightly shorter.

As shown by the interior cast the area of the ventral valve is rather long, and extends well forward on the cardinal slopes. It is divided at the center by a narrow pedicle furrow and midway by a very slight flexure line. The base of the area curves backward over the margin, arching slightly forward before reaching a rather deep indentation at the center. The striæ of growth cross the area parallel to its base. They are very sharp and fine and quite uniformly distributed over the area. Area of the dorsal valve unknown.

Observations.—This pretty species occurs in great numbers in thin layers of brown sandstone embedded in a dark shale a short distance below the *Olenus* zone. In form it resembles *Lingulella mosia osceola* (Walcott) (Pl. XVIII, figs. 2 and 2c). It differs from it in having a narrower pedicle furrow and, when comparing a large number of specimens, in being slightly more elongate. It is proportionately narrower toward the beak.

The species derives its specific name from its occurrence on Random Island.

Formation and locality.—**Upper Cambrian**: (**6y**) Sandstone on north side of Random Island, between Birch and Sandy points, Smith Sound, Trinity Bay, Newfoundland.

Lingulella rotunda (Matthew).

Plate XXXVII, figures 3h–k.

Lingulepis rotunda Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 199, Pl. XIV, figs. 4a–f. (Described and discussed as a new species.)

This small species is marked by its nearly circular, convex dorsal valve. The inner surface of the shell is strongly punctate, but I could not find the minute tubercles on the outer surface of the dorsal valve described by Matthew. The outer surface, where preserved, appears to be smooth or marked by concentric striæ.

Formation and locality.—**Middle Cambrian**: (**325a** [*Matthew, 1903, p. 199*]) *Shales of Division C2c of Matthew's* [*1903, p. 49*] *Bretonian, on the eastern slope of the valley of McNeil Brook, on the road to Trout Brook, in the Mira River valley;* (**3i**) in compact, fine-grained, thin-bedded, gray sandstone, of the *Paradoxides* zone, on McLean Brook, 1 mile (1.6 km.) east of McCodrum Brook, and 1.5 miles (2.4 km.) west of Marion Bridge; and (**325c**) sandstone on the shore of Bras d'Or Lake; all in eastern Cape Breton, Nova Scotia, Canada.

Lingulella schucherti (Walcott).

Plate XXI, figure 6.

Obolus (*Lingulella*) *schucherti* Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 689–690. (Described and discussed as below as a new species.)

General form elongate ovate, ventral valve subacuminate and the dorsal valve elongate ovate in outline. Surface marked by fine concentric striæ, and rather strong concentric undulations or lines of growth; also fine radiating striæ, and on some specimens indistinct, radiating, rather narrow, depressed furrows.

The outer surface of the inner layers shows radiating striæ and concentric lines of growth. The radiating striæ are also present on the inner surface outside of the area of the vascular cavity.

The shell is thick and formed of a thin outer layer and several thin inner layers or lamellæ arranged very much as in other shells of the genus *Lingulella*. The largest ventral valve has a length of about 11 mm.; width, 7 mm. A dorsal valve 8 mm. in length has a width of 5.5 mm.

Casts of the interior of the ventral valve show a well-marked area, with a broad, strong pedicle furrow. The base of the area arches strongly forward. Just at the center, across the pedicle furrow, however, it has a slight backward arch. None of the specimens show the flexure line or the extent of the area along the cardinal slopes of the valve. The area of the dorsal valve is unknown. None of the characters of the visceral cavity or vascular markings are shown with sufficient clearness to describe them. A tubercle on each side of the median line, just in advance of the area, indicates the main vascular sinus, and a depression the position of the anterior portion of the visceral cavity.

Observations.—This is probably the oldest species of the genus *Lingulella*. It is associated with *Botsfordia cælata* (Hall), *Elliptocephala asaphoides* Emmons, and other characteristic species of the Lower Cambrian. In its elongate dorsal valve it recalls *Obolus rhea* Walcott of the Middle Cambrian (Pl. IX, figs. 1, 1a–c). It differs from that species in the character of the shell and the outline of the valve.

The specific name is given in honor of Prof. Charles Schuchert, who collected the only specimen of the species known to me.

Formation and locality.—**Lower Cambrian**: (367) Conglomerate and limestone, Troy, Rensselaer County, New York.

Lingulella siemiradzkii (Walcott).

Plate XXXI, figures 2, 2a.

Lingula sp. cf. *exunguis* Eichwald, Siemiradzki, 1886, Jahrb. K.-k. geol. Reichsanstalt for 1886, Bd. 36, Hft. 4, p. 672. (Mentioned in German.)

Lingula cf. *exunguis* Eichwald, Gürich, 1892, Neues Jahrb. für Mineralogie, Bd. 1, p. 69. (Mentioned in German.)

Lingula sp. *Lingula* aff. *exungui* Eichwald, Gürich, 1896, Verhandl. Russ.-kais. min. Gesell. St. Petersburg, 2d ser., Bd. 32, p. 214. (Discussed.)

Obolus (*Lingulella*) *siemiradzkii* Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 690–691. (Discussed as below as a new species.)

Attention was called to this species by Siemiradzki [1886, p. 672] in connection with his study of the Paleozoic rocks of the Mittelgebirge of Poland. He speaks of it as "*Lingula* sp." in the black conglomerate, and compares it with "*L. exunguis* Eichwald." In the associated gray sandstone he found an *Obolus* which he says is identical with "*O. siluricus* Eichwald."

Gürich discusses the Cambrian of Sandomierz in a paper on the Paleozoic of the Mittelgebirge, and mentions [1896, p. 17] Siemiradzki's discovery of fossils in the lower sandstones and shales.

Gürich added greatly to the fauna found by Doctor Siemiradzki. He mentions [1896, p. 17] *Paradoxides* cf. *tessini*, *P. bohemicus*, *Agnostus fallax*, *A. gibbus*, and *Liostracus linnarssoni*, and refers the fauna to the Middle Cambrian. The "*Lingula*" he compares [1896, p. 214] with "*Lingula crassa* Eichwald," calling attention to the resemblance in the surface characters; also to those of *Lingulella davisi* (McCoy).

This is a small shell belonging to the group of species containing *Lingulella ferruginea* Salter, *L. desiderata* (Walcott), etc. The outer surface is marked by concentric, slightly undulating, and imbricating striæ of growth, and the outer surface of the inner layers by fine radiating striæ. The general form and other characters are represented in Plate XXXI, figures 2 and 2a.

Through the kindness of Dr. Fr. Schmidt I received a fragment of gray quartzitic sandstone containing a large number of specimens of the "*Lingula*" of Siemiradzki. The shell

proves to be a true *Lingulella*. In the same piece of rock an obscure form of *Obolus* occurs that may be a medium-sized *Obolus apollinis* Eichwald. I take pleasure in naming the *Lingulella* after its discoverer, Dr. J. S. Siemiradzki.

FORMATION AND LOCALITY.—**Middle Cambrian**: (368) Quartzitic sandstone in the Pepper Mountains, near Sandomierz, on the Vistula, Russian Poland.

LINGULELLA ? SIGNATA (Barrande).

Plate XXX, figure 11.

Lingula ? signata BARRANDE, 1868, Faune silurienne des environs de Hof, en Bavière, p. 103, fig. 73. (Described and discussed in French as a new species. Fig. 73 is reproduced in this monograph, Pl. XXX, fig. 11.)

Lingula ? signata BARRANDE, 1868, Neues Jahrb. für Mineralogie for 1868, p. 692, unnumbered plate, fig. 73. (Copy of preceding reference.)

This species is doubtfully referred to *Lingula* by its author. It is oval in outline, with a strongly arched surface. Where the shell is partly removed two small, elongate impressions are seen near what is supposed to be the posterior portion of the valve, and on the front portion of the shell a longitudinal groove. Barrande [1868a, p. 103] remarks that the latter recalls the perforation of *Discina;* but it is not perforated, as the shell continues over the entire surface of the depression. The aspect of the shell is horny and without ornamentation. Length, 2.5 mm.; width, 2 mm.

It is very doubtful if this species should be referred to *Lingulella*, but it may possibly be a rounded dorsal valve somewhat like that of *L. mosia* (Hall), *L. ferruginea* Salter, or *Lingulella* (*Lingulepis*) *acuminata* (Conrad).

FORMATION AND LOCALITY.—**Passage beds** between the Upper Cambrian and the Ordovician: (**303c** [Barrande, 1868a, p. 103]) Suburbs of Hof, Bavaria, Germany.

LINGULELLA SIMILIS (Walcott).

Plate XXI, figures 2, 2a–j, 3, 3a–d.

Obolus (*Lingulella*) *similis* WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 415–416. (Described and discussed as below as a new species.)

Shell small, general form ovate, with the ventral valve subacuminate, and the dorsal valve rounded ovate in outline. There is some variation in the outline of the valves; this may be seen by comparing Plate XXI, figures 2 and 2b, of the ventral valve, and figures 2a and 2c of the dorsal valve. Surface of the shell marked by concentric lines of growth and very fine, slightly irregular, concentric striæ. Where the outer surface is well preserved, fine radiating striæ may be seen with a strong magnifying glass. When the outer layer of the shell is exfoliated the outer surface of the inner layer is marked by fine concentric lines and very fine numerous radiating striæ; the inner surface of the shell shows concentric lines of growth and faint, scattered pits or punctæ. The shell is of medium thickness and formed of a thin outer layer, with one or more inner layers or lamellæ. The latter are especially prominent toward the front, where they have essentially the same arrangement as in *Lingulella acutangula* (Roemer). The average length of the ventral valve is from 4 to 5 mm.; width, 2.5 mm. An associated dorsal valve 4 mm. in length has a width of 3 mm.

A cast of the interior of a ventral valve shows a clearly defined area of medium length. It is divided midway by a cast of a narrow, strong pedicle furrow, and on each side by flexure lines situated about two-thirds the distance from the pedicle furrow to the lateral margin; a few indistinct striæ cross the area parallel with its base. The area of the dorsal valve as seen in a cast is well defined and rather large; it is marked by fine, transverse striæ of growth and indistinct flexure lines. A cast of the interior of the dorsal valve shows a trace of the visceral cavity and a narrow median septum. The only muscle scars observed are the two umbonal scars in the ventral valve (g), figure 2, and the central (h) and the anterior lateral scars (j) of the dorsal valve, figure 2a.

Observations.—This very pretty little species occurs in abundance in the compact gray limestone of the Black Hills associated with numerous fragments of trilobites and *Dicellomus nanus* (Meek and Hayden). The more elongate forms strongly resemble *Lingulella perattenuata* (Whitfield), which occurs in the Middle Cambrian sandstones on the southern margin of the Black Hills. The species differs, however, from the latter in being more ovate and in having the dorsal valve more obtusely rounded posteriorly. This species may be also compared with *L. desiderata* (Walcott) and *L. manticula* (White). When flattened in the shales it is difficult to distinguish it from *L. desiderata*.

A small shell occurs in the "St. Croix sandstone" of the upper Mississippi region that appears to be identical with this species, both in its typical form and in its comparatively wide range of variation. With the somewhat abundant supply of material from both the Black Hills and Wisconsin, I am unable to determine any specific differences that are constant. The same is true of the form in the limestones south-southwest of Potosi, Missouri, where it is associated with *Linnarssonella girtyi* Walcott.

The same range of variation occurs in shells from the limestone in the upper part of the Reagan sandstone of Oklahoma, and apparently they are identical.

In the shaly sandstones of the Rome formation in Tennessee casts of an apparently identical form occur (Pl. XXI, figs. 3, 3a–d). The variation between the Tennessee and South Dakota shells does not appear to be greater than the range of variation among the shells from the same locality in the Black Hills and the localities where it has been identified in Wisconsin and Minnesota.

In a limestone at the north end of the Quinn Canyon Range, Nevada, J. E. Spurr, of the United States Geological Survey, collected a number of small shells that appear to be identical with this species. The shells are well preserved and have the general form of surface characteristic of the species. A single specimen of a larger ventral valve has all the characteristics of *L. manticula* (White).

A shell from Middle Cambrian limestones at Mount Nebo, Wasatch Range, Utah, is doubtfully referred to this species. It is associated with *Micromitra* (*Iphidella*) *pannula* (White) and *Acrotreta neboensis* Walcott.

This form owes its specific name to its marked resemblance to several other forms, from each of which, however, it is distinct.

Formation and locality.—**Upper Cambrian**: (**12m**) Arbuckle limestone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 30 feet (9.1 m.) above the Reagan sandstone), in NE. ¼ sec. 2, T. 2 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County, Oklahoma.

(**12n**) Limestone of the Reagan sandstone (in the section 7 miles (11.27 km.) north of Springer this horizon is about 240 feet (73 m.) above the porphyry contact and 40 feet (12 m.) below the Arbuckle limestone), NW. ¼ sec. 1, T. 2 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County; (**12k**) limestone of the Reagan sandstone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 225 feet (69 m.) above the porphyry contact and 55 feet (17 m.) below the Arbuckle limestone), on the west side of Honey Creek, near the southeast corner of sec. 35, T. 1 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County; (**12p**) about 225 feet (69 m.) above the igneous rocks in the limestone of the Reagan sandstone, at the northwest extremity of the Arbuckle Mountains, about 4 miles (6.4 km.) east of Homer, Carter County; all in Oklahoma.

(**9r**) About 45 feet (14 m.) above the porphyry contact in the limestone of the Reagan sandstone, SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W.; (**9s**) about 85 feet (26 m.) below the Arbuckle limestone in the limestone of the Reagan sandstone, middle of west half of sec. 13, T. 4 N., R. 13 W.; (**9t**) about 170 feet (52 m.) above the porphyry contact in the limestone of the Reagan sandstone, SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W.; and (**9u**) about 195 feet (59.4 m.) above the porphyry contact in the limestone of the Reagan sandstone, SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W.; all about 15 miles (24.2 km.) northwest of Fort Sill, Comanche County, Oklahoma.

(**328a**) "St. Croix sandstone" 4 miles (6.4 km.) north of Winfield; and (**97a** and **97c**) "St. Croix sandstone" near Winfield; both in Jefferson County, Wisconsin.

(**78b**) "St. Croix sandstone" 50 feet (15.2 m.) above St. Croix River, near the landing at Osceola, Polk County; (**328n**) "St. Croix sandstone" 2 miles (3.2 km.) south of Osceola, Polk County; and (**80a**) "St. Croix sandstone" 4 miles (6.4 km.) north of Reedsburg, Sauk County; all in Wisconsin.

(**86a**) "St. Croix sandstone" near Redwing, Goodhue County; (**339d**) "St. Croix sandstone" at Taylors Falls, Chisago County; (**82c**) conglomerate beds in the "St. Croix sandstone" in point below Franconia, Chisago County;

(97s) "St. Croix sandstone" at Franconia, Chisago County; and (97) "St. Croix sandstone" at Reads Landing, foot of Lake Pepin, Wabasha County; all in Minnesota.

Middle Cambrian: (7j) Limestones at the north end of the Quiun Canyon Range, 1 mile (1.6 km.) northwest of the Italian Ranch foothills, Nye County, Nevada.

(360d) Siliceous limestones near Pike View, north of Colorado Springs, El Paso County, Colorado.

(355a) Shales in Bear Gulch Valley; (88a) *limestone about 100 feet (30.5 m.) above the quartzitic sandstone at the base of the Cambrian in the northern suburbs of Deadwood;* (165) limestone on the east side of the valley, in railroad cut about 1 mile (1.6 km.) below the main part of Deadwood; and (17j) limestone in the east end of the town of Galena; all in the Black Hills, South Dakota.

(11e) Thin-bedded limestones south-southwest of Potosi, Washington County, Missouri.

(10a) Sandy layers of the Rome formation, in western railroad cut through Shooks Gap, and (106) shales of the Rome formation, on the roadside at the eastern base of Shooks Gap; both in Bays Mountains, 10 miles (16.1 km.) southeast of Knoxville [Keith, 1895, areal geology sheet], Knox County, Tennessee.

(9a) Limestone on the south shore of the Holston River at Melinda Ferry, 5 miles (8 km.) southwest of Rogersville [Keith, 1896a, areal geology sheet], Hawkins County, Tennessee.

(14a) Sandstone of the Rome formation along First Creek Gap, 4 miles (6.4 km.) north-northeast of Knoxville [Keith, 1905, areal geology sheet], and (374) in the suburbs of and 4 and 11 miles (6.4 and 17.7 km.) north-northeast of Knoxville; both in Knox County, Tennessee.

(138) Shale in the street northeast of Printuf House, Gadsden, Etowah County, and (145) shale in bluff on Coosa River east of Turkeytown, 8 miles (12.8 km.) northeast of Gadsden, Etowah County; both in Alabama.

(362a) Sandy shale a short distance west of Cave Spring; (138a) shales in the Rome formation west of the cemetery west of Rome; and (140c) shales at edge of hill on the road leading west of Cave Spring; all in Floyd County, Georgia.

Specimens that are somewhat doubtfully referred to this species occur at the following localities:

Middle Cambrian: (14t) Limestone lying on slope between the Cambrian quartzite and the massive blue limestone 100 feet (30.5 m.) above, Mount Nebo Canyon, 3 miles (4.8 km.) southeast of Mona, Juab County, Utah.

(92x) Conasauga ("Coosa") shale, at Yanceys Bend, Coosa River; and (90) Conasauga ("Coosa") shale on Edwards's farm, near Craigs Mountain; both southeast of Center, Cherokee County, Alabama.

Lingulella? simplex (Barrande).

Plate XXXII, figures 4, 4a–b.

Lingula simplex Barrande, 1879, Système silurien du centre de la Bohême, vol. 5, pt. 1, Pl. CIV, figs. VI: 1–4. (Not described, but figured as a new species. Figs. 1A, 4A, and 4B are reproduced in this monograph, Pl. XXXII, figs. 4, 4a–b, respectively.)

This species, like *Lingulella? insons* (Barrande), is one of the forms that, with the present evidence, is probably to be referred to *Lingulella*. All that is known to me of the species is shown in the figures copied from Barrande.

Formation and locality.—**Lower Ordovician:** (303a) Étage D3 at Trubin; and (303p) *Étage d3 in the environ of Beraun;* both [Barrande, 1879b, Pl. CIV] in Bohemia, Austria-Hungary.

Lingulella tarpa (Walcott).

Plate XXIII, figures 2, 2a–c.

Obolus (Lingulella) tarpa Walcott, 1898, Proc. U. S. Nat. Mus., vol. 21, pp. 417–418. (Described and discussed as below as a new species.)

General form elongate ovate, with the ventral valve subacuminate, and the dorsal valve ovate in outline. There is considerable range of variation in the outline of both valves, owing in part, possibly, to distortion. The convexity of the two valves is fairly strong, as far as can be determined from the somewhat compressed condition of the shells in the shale and calcareous sandy shales. The largest ventral valve in the collection has a length of 14 mm. The average length of the ventral valve is from 10 to 12 mm. One 11.5 mm. in length has a width of 8 mm.

None of the specimens of the collection show the outer surface, and only traces of concentric and radiating lines have been observed on the inner surface. The shell appears to be moderately thick, and formed of numerous lamellæ that were oblique to the outer layer in the

anterior portions of the shell, in this respect resembling the shell of *Lingulella acutangula* (Roemer) (Pl. XVII, figs. 1m, 1o).

Casts of the interior of the ventral valve have a moderately long area divided midway by the cast of a strong pedicle furrow and marked about midway between the pedicle furrow and the lateral margin by a sharp flexure line; striæ of growth cross the area parallel with its base and arch over the cast of the pedicle furrow. The area of the dorsal valve is relatively short, arching forward slightly at the median portion. The only interior markings observed are seen in the casts of the ventral valve where the visceral area and a portion of the main vascular sinuses are imperfectly preserved.

Observations.—The external form of this species strongly recalls that of *Lingulella acutangula* (Roemer), but the material is too imperfect to identify it with the latter. It occurs at a considerably lower geologic horizon, and what is preserved of the interior markings of the ventral valve indicates a considerable difference in the position of the visceral area (Pl. XVII, fig. 1c, and Pl. XXIII, fig. 2a).

Formation and locality.—**Middle Cambrian**: (**11**) *Sandstones and shales of the Rome formation, about 1 mile (1.6 km.) east of Post Oak Springs [Hayes, 1894, areal geology sheet], Roane County;* and (**11a**) sandstone between First and Armstrong creeks, in the southeast corner of the Maynardville quadrangle (U. S. Geol. Survey), Union County; both in Tennessee.

Lingulella texana Walcott.

Plate XLIX, figures 3, 3a.

Lingulella texana Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 71, Pl. VIII, fig. 5. (Characterized as below as a new species. Fig. 5 is copied in this monograph, Pl. XLIX, fig. 3.)

This is a small but distinctly marked species, represented by two dorsal valves occurring in the Upper Cambrian limestones of central Texas. The dorsal valves are oval, and quite strongly convex. The shell appears to have been rather thick, and the outer surface is marked by strong, radiating striæ, a feature which is characteristic of the species. They are crossed by fine, concentric striæ and lines of growth. The position of the muscle scars and the size and character of the area are shown by Plate XLIX, figure 3a.

Formation and locality.—**Upper Cambrian**: (**369**) Sandstones at the base of the Elvins formation, in the eastern limits of the town of Flat River, St. Francois County, Missouri.

(**69**) Limestones near Honey Creek; and (**70**) *limestone near Morgans Creek;* both in Burnet County, Texas.

Lingulella torrentis (Matthew).

Plate XXXV, figure 7.

Leptobolus torrentis Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 74–75, Pl. VI, fig. 1. (Described as below as a new species. The specimen represented by fig. 1 is redrawn in this monograph, Pl. XXXV, fig. 7.)

Leptobolus atavus tritavus Matthew, 1903, idem, p. 109, Pl. VI, figs. 5a–c. (Characterized as a new variety.)

The original description by Matthew follows:

Shell thin, surface shining. Form elongate oval.

Ventral valve obtusely pointed at the back, somewhat acutely rounded in front; elevated along the middle; somewhat flattened along the sides within the margin.

By decortication a low boss and a transverse furrow behind it are exposed on the mold, about three-quarters of the length of the valve from the hinge; if this boss marks the front of the callus, the central muscles are unusually far forward, more advanced even than in *L. atavus* of the Etcheminian terrane. There are faint impressions of the lateral septa on the sides of the valve.

The surface of the shell is covered with minute, low tubercles, cancellate in arrangement; through these can be traced faint parallel lines, concentric to the umbo. Along the median third in places can be seen about six broad, flat ridges, radiating from the direction of the umbo; these break the continuity of the concentric ridges.

Length, 3 mm.; width, 2 mm.; depth, 0.5 mm.

The ventral valve of "*Leptobolus atavus tritavus*" Matthew is similar in form to the type of *Lingulella torrentis*. Compare figures 1 and 5a of Matthew [1903, Pl. VI]. The surface characters

appear to be identical. The dorsal valve is elongate oval in outline, resembling the same valve in *Lingulella atava* (Matthew).

FORMATION AND LOCALITY.—**Middle Cambrian**: (**344f** [*Matthew, 1903, p. 72*]) *Shales of the Coldbrook terrane of Matthew, on Dugald Brook, Indian River;* and (**344e** [Matthew, 1903, p. 78]) shales of Division E1d of Matthew's [1903, pp. 28 and 29] Etcheminian, on Boundary Brook, eastern side of the Escasonie Indian Reservation; both in eastern Cape Breton, Nova Scotia.

LINGULELLA TRIPARILIS (Matthew).

Text figures 44a–l, page 537; Plate XLV, figures 2, 2a–f.

Obolus triparilis MATTHEW, 1902, Trans. Roy. Soc. Canada, 2d ser., vol. 8, sec. 4, No. 3, p. 94, Pl. I, figs. 2a–c. (Discussed as a new species.)

Obolus discus MATTHEW, 1902, idem, p. 94, Pl. I, figs. 3a–d. (Mentioned as a new species.)

Lingulella longovalis MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 123–125, Pl. VII, figs. 3a–f. (Described and discussed as a new species. Figs. 3b and 3d are represented in outline by text figs. 44h and 44h′, respectively, p. 537, of this monograph.)

Obolus (*Eoobolus*) *triparilis* MATTHEW, 1903, idem, pp. 136–137, Pl. VIII, figs. 4a–c; Pl. IX, figs. 1a–b. (Described and discussed as a new species. Pl. VIII, figs. 4a–c, is copied from Matthew, 1902b, Pl. I, figs. 2a–c; Pl. VIII, fig. 4a, and Pl. IX, fig. 1a, are represented in outline by figs. 44b and 44b′, respectively, p. 537, of this monograph.)

Obolus (*Eoobolus*) *discus* MATTHEW, 1903, idem, pp. 138–139, Pl. VIII, figs. 3a–d. (Described and discussed as a new species. Figs. 3a–d are copied from Matthew, 1902b, Pl. I, figs. 3a–d; figs. 3a and 3c are represented in outline by figs. 44a and 44a′, respectively, p. 537, of this monograph.)

This species is distinguished from *Lingulella* (*Lingulepis*) *gregwa* (Matthew) by its outline. The range of variation in its form covers both the types of the species and the types of "*Lingulella longovalis*" Matthew and "*Obolus* (*Eoobolus*) *discus*" Matthew. Matthew assigns specific value to variations in length and breadth of the visceral areas of the valves. I do not find that this holds good, as the shells from the same layer of rocks and not distinguishable by other characters vary in the length of the visceral area of the dorsal valve from a point back of the center to nearly the front of the valve. There is also considerable variation in the ventral valve. On the same shell there is a variation of the surface characters from the nearly plain, concentric striæ to undulating striæ, with minute points on the crest. This is also true of the surface of *Lingulella* (*Lingulepis*) *gregwa* (Matthew).

The "central" scar in the dorsal valve, mentioned by Matthew [1903, p. 136] as characterizing "*Obolus* (*Eoobolus*) *triparilis*," is at the bifurcation of the median ridge, and appears to be a slight depression just in advance of the bifurcation and not a true muscle scar. The variation in outline of the valves is shown in figures 44a–l.

No specimens among the types sent by Matthew nor in our material show areas like those represented by figures 44b′ and 44h′. The area is not preserved on the dorsal valves of *L. triparilis* sent by Matthew, and the area of the dorsal valve of his "*L. longovalis*" does not extend so far down the lateral slopes of the shell as represented in the figure.

The variation in the length and strength of the visceral area in the two valves is also outlined from specimens showing their position. Among the specimens from the same layer of rock there is a transition in form from *Lingulella triparilis* to *Lingulella* (*Lingulepis*) *longinervis* (Matthew) of a somewhat later stratigraphic horizon. This is illustrated in figures 44f–k.

The surface characters are of the same type in *Lingulella* (*Lingulepis*) *gregwa* (Matthew), *L.* (*L.*) *longinervis* (Matthew), and *Lingulella triparilis*.

"*Obolus* (*Eoobolus*) *discus*" Matthew appears to be based on imperfect specimens of the short, broad form of *L. triparilis*. With the types of "*O.* (*E.*) *discus*," *L. triparilis*, and "*L. longovalis*" before me, I am not able to discover differences of specific value between them. All have the same surface characters, and the gradations in form unite them into one species.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**13t′** and **13t**)[a] *Sandstones at the base of Division E1b;* (**344g**) [Matthew, 1903, p. 77]) shales of Division E1c; (**13t″**) sandstones of Divisions E1c and E1d; (**344h** [Matthew, 1903,

[a] **13t** is the type locality, though the specimens in the United States National Museum collections to which that number was assigned were collected later than Matthew's type specimens.

p. 79]) sandy layers in the shales of Division E1e; and (**10p**) sandstone just below the waterfall in Division E2b; all in Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River Valley, eastern Cape Breton, Nova Scotia.

(**307d** [Matthew, 1903, p. 79]) Sandy limestone of Division E2a? of Matthew's Etcheminian, on Young (McFees) Point, George River, Cape Breton, Nova Scotia.

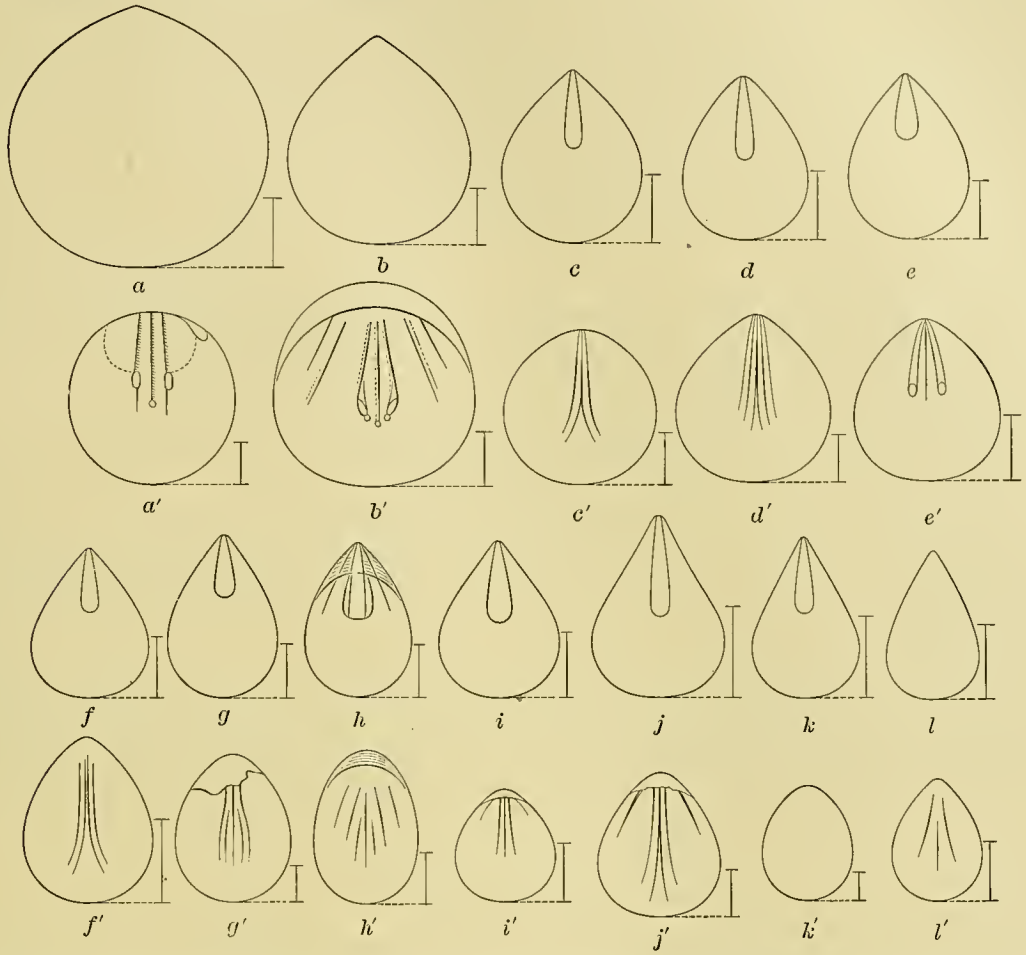

FIGURE 44.—*Lingulella triparilis* (Matthew); outlines illustrating variation in form of shells now referred to *Lingulella triparilis*. *a*, *a′*, Ventral and dorsal valves of "*Obolus* (*Eoobolus*) *discus*" [Matthew, 1903, Pl. VIII, figs. 3a and 3c]. *b*, *b′*, Ventral and dorsal valves of *Lingulella triparilis* [Matthew, 1903, Pl. VIII, fig. 4a, and Pl. IX, fig. 1a]. *c–g*, *c′–g′*, Ventral and dorsal valves from Locality **13t″**, sandstones of Division E1c of Matthew, Dugald Brook, illustrating the gradation in form between shells referred to *L. triparilis* and "*L. longovalis*." *h*, *h′*, Ventral and dorsal valves of "*L. longovalis*" [Matthew, 1903, Pl. VII, figs. 3b and 3d]. *i–l*, *i′–l′*, More elongate ventral and dorsal valves from specimens associated with those represented by *c–g*.

LINGULELLA TUMIDA Matthew.

Plate XXIV, figures 7, 7a–d.

Lingulella tumida MATTHEW, 1899, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 3, No. 18, p. 200, Pl. I, figs. 2a–c. (Described as a new species.)

Obolus (*Lingulepis*) *gregwa* WALCOTT (in part) [not (MATTHEW)], 1901, Proc. U. S. Nat. Mus., vol. 23, p. 692–694. (Matthew's *Lingulella tumida* is here referred to and described with *Lingulella* (*Lingulepis*) *gregwa*.)

Lingulella tumida MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 123, Pl. VI, figs. 6a–c. (Described and discussed. Figs. 6a–c are copied from Matthew, 1899b, Pl. I, figs. 2a–c.)

This shell resembles *Lingulella martinensis* Matthew and some forms of *Lingulella* (*Lingulepis*) *exigua* (Matthew) in outline of the valves. At first I thought it should be placed with the latter species, which I had [1901, p. 692] by error identified with *Lingulella* (*Lingulepis*) *gregwa* (Matthew). It is uniformly smaller than *L.* (*L.*) *exigua*, and differs in the more uniform concentric lines and striæ of growth.

Matthew's material is poor, but in the collections made by S. Ward Loper there is an abundance of specimens showing some variations in form. The surface is marked by strong, concentric lines of growth, with narrow bands of finer and somewhat minutely irregular striæ. Depressed, irregular, and bifurcating radiating lines show on very perfectly preserved shells.

FORMATION AND LOCALITY.—**Middle Cambrian**: (13i) Sandstones of the "Johannian" Division of Matthew's section, on Gillis Brook, East Bay, east of Bras d'Or Lake; and (13r) sandstone at a little different horizon than that of Locality 13i, on Gillis Brook, East Bay, east of Bras d'Or Lake; and (13n′)[a] *sandstones of Division E3e of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River;* all in eastern Cape Breton, Nova Scotia.

LINGULELLA UPIS (Walcott).

Plate XXXVI, figures 3, 3a.

Obolus (*Lingulella*) *upis* WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 331–332. (Described and discussed as below as a new species.)

This is a small, elongate shell of the group to which *Lingulella ora* (Walcott) belongs. It differs from the latter in being more elongate and in its marked surface characters, and from *L. collicia* (Matthew), *L. flumenis* (Matthew), *L. cania* (Walcott), and allied forms, in having a thick, strong shell and highly characteristic exterior surface.

The shell is thick, the anterior portions being made up of numerous lamellæ oblique to the exterior surface, in this respect resembling some of the species of *Obolus* having thick shells. The exterior surface is marked by concentric lines of growth, with very fine, somewhat irregular striæ between them. These show very distinctly in the anterior portion of the shell. Further back they become very irregular, giving a crenulated appearance to the striæ and lines of growth, and the surface looks as though it was formed of thin, imbricating scales or lamellæ.

Observations.—The surface of *Lingulella upis* suggests that of *Obolus* (*Westonia*) *euglyphus* (Walcott), but I have been unable to find traces of the transverse lines characteristic of *Westonia*.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**14g** and **14i**)[b] *Upper part of the limestones exposed 1 mile (1.6 km.) west of Cherokee, San Saba County;* and (**14b**) limestone on Cold Creek, at north end of gorge opposite the north end of Sponge Mountain, 2 miles (3.2 km.) south of the San Saba County line, in Llano County; both in Texas.

LINGULELLA WANNIECKI Redlich.

Plate XXXIX, figures 1, 1a–n.

Lingulella wanniecki REDLICH, 1899, Mem. Geol. Survey India, Paleontologia Indica, new ser., vol. 1, No. 1, The Cambrian Fauna of the Eastern Salt Range, p. 7, Pl. I, figs. 9a–d. (Described and discussed as a new species.)
Obolus (*Lingulella*) *wanniecki* (Redlich), WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 332. (Described and discussed as below.)

General form broadly ovate, with the ventral valve obtusely acuminate and the dorsal valve rounded subtriangular; convexity moderate in the specimens embedded in argillaceous shales. There is considerable range of variation in the outline of the valves; this is shown in Plate XXXIX, for the ventral valve by figures 1, 1a–f, and for the dorsal valve by figures 1g–m. All that is known to me of the interior markings of the ventral valve is shown by figures 1d–f, and of the dorsal valve by figures 1l–n. The surface of the shell is marked by concentric lines of growth and very fine closely undulating raised striæ that inosculate so as to give the surface a granulated appearance. This type of surface occurs on *Lingulella isse* (Walcott) and *L. upis* (Walcott). The anterior layers of the shell are marked by radiating and concentric striæ, and the interior of the shell has scattered punctæ in addition to the radiating and concentric striæ. The shell is relatively thick and formed of several layers or lamellæ in addition to the very thin outer ornamented layer.

The visceral area of the ventral valve is short, and the main vascular sinuses are about halfway between the center of the shell and the lateral margins. In the dorsal valve the

[a] **13n′** is the type locality, but the specimens in the United States National Museum to which that number is assigned were collected later than the type specimens.
[b] **14i** is the type locality.

visceral area is well developed beyond the center of the shell, and the vascular sinuses are farther out proportionately than in the dorsal valve. The central and anterior lateral muscle scars are placed on an elevated central ridge, on each side of a sharp median septum.

Observations.—This very pretty little shell occurs in great numbers in the dark argillaceous shales with *Redlichia noetlingi* (Redlich). Redlich [1899, p. 7] states that it is the only species of the genus in the collection sent to him. In the collections made by Fritz Noetling I find associated with *Redlichia noetlingi, Lingulella wanniecki, L. fuchsi* Redlich, *Acrothele (Redlichella) granulata* (Linnarsson); also specimens of a species of undescribed *Hyolithes.*

Among the American species of *Lingulella, L. wanniecki* may be compared in form with *L. desiderata* (Walcott) and *L. oweni* (Walcott). Its surface is much like that of *L. upis* (Walcott) and *L. ora* (Walcott). It is distinct from all described species when its form and surface are taken into consideration, as there is no species with its subtriangular form that has its granulated surface.

The formations containing this fauna are referred to the Middle Cambrian, as there is no evidence that the Cambrian fauna of India above the upper "Annelid sandstone," as described by Noetling and Redlich, is older.

Formation and locality.—**Middle Cambrian:** (15r) [a] Dark argillaceous shales at Khussak, Salt Range, India.

Lingulella welleri (Walcott).

Plate XXXVIII, figures 4, 4a–b.

Obolus (Lingulella) welleri Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 608. (Described and discussed essentially as below as a new species.)

General form elongate ovate, with the ventral valve subacuminate and the dorsal valve subelliptical. Owing to the more or less crushed condition of all the specimens the exact convexity of the entire valve is unknown. Surface of the shell marked by numerous elevated concentric lines of growth and very fine slightly irregular interstitial concentric striæ.

When the outer edge is exfoliated the inner layers show fine radiating striæ and concentric lines of growth. Nothing is known of the interior surface of the shell. The shell appears to have been relatively thin and formed of several layers or lamellæ.

A ventral valve 14 mm. in length has a width of 9 mm. and a dorsal valve 10 mm. in length has a width of 7.5 mm. In both valves the width is slightly increased by the flattening of the shell.

Observations.—This species occurs in association with *Obolus (Westonia) stoneanus* (Whitfield) in an arenaceous, magnesian limestone. It differs from described species of *Lingulella* in the elliptical form of its dorsal valve and the strongly filose concentric striæ of the outer surface.

The dorsal valve has the outline of that of *Obolus (Westonia) stoneanus* but the ventral valve is more acuminate and the characteristic *Westonia* surface of the latter is absent. Some specimens of *O.* (*W.*) *stoneanus* have the transverse imbricating lines only on the posterior half of the valve, in which case the anterior half is much like that of *Lingulella welleri.*

The specific name is given in honor of Prof. Stuart Weller, who discovered the locality.

Formation and locality.—**Upper Cambrian:** (11c) Hardyston quartzite [Weller, 1900, pp. 10 and 12], O'Donnell and McManniman's quarry, Newton, Sussex County, New Jersey.

Lingulella winona (Hall).

Plate XVIII, figures 3, 3a–b.

Lingula winona Hall, 1863, Sixteenth Rept. New York State Cab. Nat. Hist., p. 126, Pl. VI, fig. 9. (Described as a new species; see p. 540 for copy.)

Lingula winona Hall, 1867, Trans. Albany Inst., vol. 5, p. 102, Pl. I, fig. 9. (Copied from preceding reference.)

[a] Specimens from the type locality were given to the United States National Museum and this number was assigned to them.

Lingula winona Hall, Sardeson, 1896, Bull. Minnesota Acad. Nat. Sci., vol. 4, No. 1, pt. 1, p. 96. (Characterizes specimens from new locality.)

Lingulella winona (Hall), Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 258. (Merely changes generic reference.)

The original description by Hall follows:

Shell small, subquadrilateral, the front nearly straight; sides nearly straight and parallel; apex obtuse, the cardinal margins sloping at an angle of 80 degrees. Surface marked by fine concentric striæ.

A cast of part of a ventral valve from Osceola, Wisconsin, that appears to belong to this species, shows the visceral area and the main vascular sinuses (Pl. XVIII, fig. 3). This shell is more convex and has a more rounded outline than the type shell, but I think that this is owing to the fact that the type shells are pressed flat in the sandy shales and to a degree distorted. Flattened shells at Osceola are much more quadrate in outline.

The species has been found at a number of localities, but very little more can be added to the original description. The shell, although very small, is built up of two or more layers that are lamellose toward the front of the shell. The outlines of the two valves when compressed are shown by Plate XVIII, figures 3a and 3b.

The nearest form to *Lingulella winona* is *L. mosia* (Hall) of the Upper Cambrian. It differs in the uniformly smaller size and its regular subquadrate outline.

The specific name is derived from Winona, Minnesota.

Formation and locality.—**Upper Cambrian**: (**78** and **78c**) "St. Croix sandstone," quarry near St. Croix River in suburbs of Osceola, Polk County; (**85x**) upper beds of the "St. Croix sandstone" near Mazomanie, Dane County; (**10v**) shaly beds in the "St. Croix sandstone," at Fox Glen, 8 miles (12.8 km.) east of Baraboo, Baraboo quadrangle (U. S. Geol. Survey), Sauk County; (**79**) "St. Croix sandstone" in bluff near Hudson, St. Croix County; and (**85s**) "St. Croix sandstone" at Prairie du Sac, Sauk County; all in Wisconsin.

(**113**) "St. Croix sandstone" at La Grange Mountain (or Barn Bluff), near Red Wing, Goodhue County, Minnesota.

(**341**) *Near Lansing, Allamakee County, Iowa.*

Lingulella winona convexa (Walcott).

Plate XVIII, figures 4, 4a–d.

Obolus (*Lingulella*) *winona convexus* Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 691. (Discussed as below as a new variety.)

A small relatively convex shell occurs abundantly in the brown sandstones at Osceola that appears to be an intermediate form between *Lingulella winona* (Hall) and *L. mosia* (Hall). It differs from *L. mosia* in being a shorter shell, and from *L. winona* in the more regularly ovate to semicircular dorsal valve and more acuminate ventral valve.

Observations.—The group of shells represented by *L. winona, L. mosia,* and their varieties appears to range from the Middle Cambrian beds of Hudson, Wisconsin, up and into the Upper Cambrian beds of Osceola, Wisconsin. There is so much variety of form owing to the conditions of preservation that it is very difficult to be always sure of the correctness of the specific reference. The variety *convexa* may be only the uncompressed form of *L. winona,* which is usually flattened in the shaly sandstones, or it may be a distinct species. From the material available for comparison this can not be clearly determined.

Formation and locality.—**Upper Cambrian**: (**78**, **78s**, and **78c**)[a] *"St. Croix sandstone" in quarry near St. Croix River in suburbs of Osceola, Polk County;* (**79**) "St. Croix sandstone" in bluff near Hudson, St. Croix County; (**85x** and **S85x**) upper beds of the "St. Croix sandstone," near Mazomanie, Dane County; (**100**) "St. Croix sandstone" near Menomonie, Dunn County; (**79a**) "St. Croix sandstone" in quarry and ledge, 0.5 mile (0.8 km.) southeast of the county courthouse, Menomonie, Dunn County; (**80**) "St. Croix sandstone" 0.66 mile (1.1 km.) southwest of the railway depot, Menomonie, Dunn County; (**85s**) "St. Croix sandstone" at Prairie du Sac, Sauk County; and (**135**) "St. Croix sandstone" near Trempealeau, Trempealeau County; all in Wisconsin.

(**75**) "Tonto" sandstone, near the water's edge at the mouth of Kanab Canyon, where it enters the Grand Canyon of the Colorado, Arizona.

[a] **78** is the type locality.

Lingulella wirthi (Barrande).

Plate XXX, figure 7.

Lingula wirthi Barrande, 1868, Faune silurienne des environs de Hof, en Bavière, p. 101, fig. 63. (Described and discussed in French as a new species. Fig. 63 is reproduced in this monograph, Pl. XXX, fig. 7.)

Lingula wirthi Barrande, 1868, Neues Jahrb. für Mineralogie for 1868, p. 691, unnumbered plate, fig. 63. (Copy of preceding reference.)

This is a more elongate shell than *Obolus? bavaricus* (Barrande), and is known only by several casts. It has a length of 15 mm.; greatest width, 9 mm. In many respects it resembles *Lingulella davisi* (McCoy) of the *Lingula* flags of Wales. The outer surface is marked by concentric lines and striæ, as far as can be determined from the casts.

Formation and locality.—**Passage beds** between the Upper Cambrian and the Ordovician: (**303e** [*Barrande, 1868a, p. 101*]) *Suburbs of Hof;* and (**303f** [Pompeckj, 1896a, pp. 7 and 8]) railway cut near Schellenberg, a little distance back of the railway station at Neuhof, near Hof; both in Bavaria, Germany.

Lingulella zeus n. sp.

Text figure 45.

This species is represented by one very minute specimen, a poorly preserved interior of a suborbicular ventral valve, showing a fairly well defined area. The exterior surface was covered with strong concentric striæ.

Observations.—This specimen is of particular interest as the only representative of the genus *Lingulella* from Scotland, where it occurs associated with *Olenelloides armatus*. The species is too poorly preserved for further description or comparison.

Figure 45.—*Lingulella zeus* n. sp. Interior of a ventral valve, the type and only specimen, × 12, from Locality **316c**, Lower Cambrian shales near Loch Maree, Ross-shire, Scotland. The specimen is numbered M4197d in the collections of the Geological Survey of Scotland.

Formation and locality.—**Lower Cambrian:** (**316c**) Shales from Locality M4197d of the Geological Survey of Scotland, a band probably equivalent to either 6 or 7 of the section on the north slope of Meall á Ghiubhais [Peach and Horne, 1907, p. 414] on the Bruachaig River, 2 miles (3.2 km.) east-northeast of the Kinlochewe Hotel, Loch Maree, Ross-shire, Scotland.

Lingulella sp. undt. a.

Plate XXX, figure 13.

There are two specimens of the dorsal valve in the collection from the *Olenus truncatus* zone. The outer surface is marked by fine radiating and concentric striæ, and the inner surface by large punctæ, scattered, as far as known, in the anterior half of the valve.

Formation and locality.—**Upper Cambrian:** (**310k**) Oeland Island, Sweden.

Lingulella sp. undt. b.

Imperfect specimens of a small, rather broad form of *Lingulella* occur in Middle Cambrian shales at York, Pennsylvania. The outline of the shells is somewhat like that of *Obolus willisi* (Walcott), but the material is too poor for specific determination.

Formation and locality.—**Middle Cambrian:** (**48d**) Argillaceous shales in the railroad cut beside the gas house, York, York County, Pennsylvania.

LEPTEMBOLON Mickwitz, subgenus of LINGULELLA.

[λεπτός, small; and ἔμβολον, a wedge.]

Obolus (*Leptembolon*) Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, p. 199. (Characterized and discussed as a new subgenus; see below for translation.)

Obolus (*Leptembolon*) Mickwitz, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, no. 4, Pl. XI, and pp. 142 and 144. (Classification of subgenus.)

The original description by Mickwitz follows:

The subgenus *Leptembolon* is based on a species of *Obolus*, which externally resembles *Lingula* very closely, and in fact was by earlier authors regarded as such. The specimens of the internal surfaces of the valves, however,

showed, together with some suggestions of the last-mentioned genus [*Lingula*], unmistakable marks of the genus *Obolus*, so that the species, which would not be assigned to any of the other groups, had to be ranked in a special subgenus of Eichwald's genus.

The internal characteristics of the Cambrian and Silurian Lingulæ have not hitherto been established so completely as to render it possible to compare the organization of this extinct group in detail with the recent *Lingula*. It is probable that more accurate knowledge of these oldest Lingulæ will lead to a change in the generic designation. A similar uncertainty of course exists also in regard to the relations of the genus *Obolus* to the above-mentioned Lingulæ, and if it be possible to ascertain the internal features of the latter to the same extent as in the genus *Obolus*, *O. lingulæformis* will probably become the connecting link between these old extinct genera.

Lingulella (Leptembolon) lingulæformis (Mickwitz).

Plate XIV, figures 5, 5a–b.

Obolus (*Leptembolon*) *lingulæformis* Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 200–204, Pl. III, figs. 10–17. (Described and discussed in German as a new species; see below for translation. Figs. 17a–b are copied in this monograph, Pl. XIV, fig. 5.)

Obolus (*Leptembolon*) *lingulæformis solidus* Mickwitz, 1896, idem, pp. 204–205, Pl. III, figs. 18 and 19. (Described and discussed in German as a new variety.)

The original description by Mickwitz follows:

Shells moderately large, quite flatly arched. Outline pointedly oval to subtriangular. Beak and posterior part of shell laterally somewhat flattened, forming two slightly pronounced roundish edges, which converge to the tip of the beak. Anterior part of shell similarly flattened toward the anterior border.

Surface of shell very smooth, very lustrous, like varnish. Concentric striæ very fine and regular, especially sharp cut at the posterior borders. Growth lamellæ indistinctly bordered. In age, clearly distinguishable by the somewhat projecting borders of the lamellæ. Anterior and lateral borders very thin, sharp-edged, brittle, lying in the plane with the uncovered umbonal borders. Posterior part of the shell scarcely thickened, area more in shape of covering of the hollow tip of the beak. Pleurocœlic part of the area somewhat prolonged into the lateral borders. Peduncular groove very broad, somewhat diminished toward the tip of the beak, lying deep but only flatly arched on account of the deficient thickening of the beak. Traces of the pseudo-area rectilinear, converging to the tip of the beak.

Splanchnocœle of the large shell (ventral valve) drawn forth, anterior point of the same bordered in the shape of a bow, and somewhat projecting. Terrace of the thickening of the posterior part of the shell diverging into the brachiocœle, longitudinally palmately striate. Central groove of large shell very flat, posterior part indefinitely bordered, tip drawn out, parallel bordered and anteriorly semicircularly rounded. Corneous processes of the small shell (dorsal valve) strongly receding, sinus indefinitely flattened. Median swelling of small shell strongly developed, beginning in the sinus as a thin, roundish ridge, gradually swelling, reclining beyond the places of attachment of the anterior lateral muscles, and ending shortly before the anterior border in the shape of a pestle. Principal vessels distinguishable in their beginnings, not traced in the brachiocœle. Peripheral canals and accessory vascular furrows in both shells only distinguishable in indistinct traces. Places of attachment of the umbonal muscles large, longitudinally striate, not to be separated from the place of attachment of the peduncular muscle in the large shell. Places of attachment of the central and outside lateral muscles to both sides of the central groove of the large shell, separated from each other and from those of the middle lateral muscles. The latter lie before the semicircularly bordered apex of the central groove. Central muscles (with their advance corresponding to the growth of the animal) leaving behind, in the small shell, a row of traces, which converge into the sinus. Places of attachment of the combined outside and middle lateral muscles, as also those of the transmedian muscles of the small shell, very near the border of the shell.

Observations: The shells of *O. lingulæformis* show a different form of outline in their youth than in their age. For the species of the subgenus *Euobolus*, we have demonstrated a proportional growth, and the same also takes place in the species of the other subgenera, as the consideration of the concentric striæ teaches, which marks the stages of age. The form of outline remains the same, except in the very first stages of youth. In *O. lingulæformis* the outline of the shell is elliptic until in old age, and then first begins to become subtriangular through the growth lamellæ projecting mostly at the anterior border and anterior lateral borders. Self-evidently, the separation of the substance of the shell takes place also in this stage along the entire border of the shell (including the area), but the lamellæ run, so far as their external part (which forms the surface of the shell) comes into consideration, so sharply into the lateral borders that they do not help to broaden the posterior borders of the shells, but only to thicken them vertically. The outline of the posterior part of the shell, therefore, remains the same, while the anterior part steadily gains in breadth.

In connection with this manner of formation stand the extraordinarily sharply sculptured concentric striæ at the lateral borders of the shell, which are closely crowded against each other.

This characteristically subtriangular outline, which, in connection with the flat arching of the shell, marks the typical form of *O. lingulæformis*, is, however, in some specimens given to essential deviations. The beak becomes

broader, and the form of the outline approaches more to the elliptic. At the same time the shell is much more strongly arched. A small shell whose outline deviates only slightly from the typical form is arched much more than the normal specimens. These transition forms point, as we see, toward the variety *solidus*.

The typical form shows two slightly pronounced roundish edges which converge into the tip of the beak and are caused by a lateral flattening of the posterior part of the shell. In like manner the anterior part of the shell is somewhat flattened toward the anterior border. These characters are first plainly perceptible by reflected light, and are much less developed in the described roundish forms. A peculiar correlation also seems to exist between the form of the shell and the strength of the shell. The latter is the slightest in the typical form, increases in the roundish form, and acquires the maximum in *O. lingulæformis solidus*.

The thinness of the shell of the species in question is pronounced, especially in the deficient thickening of the tip of the beak, which in this regard reminds one of the recent lingulas. Here, as well as there, the broad posteriorly diminished peduncular groove is shallow and only indefinitely bordered, and sunk in the area of the large shell. *O. lingulæformis* reminds one, more than all other species of Eichwald's genus, in the formation of the area of the small shell, of the recent *Lingula* with which this part is, to be sure, in a still more pronounced manner, a mere covering of the thin-walled tip of the beak with the corneous area lamellæ.

The configuration of the inner surface of the shell is, in relation to the deficient thickening, quite distinctly developed. In its projecting tip the splanchnocœle of the large shell in some measure resembles the corresponding formation of *Lingula anatina*. On the other hand, the small shell shows the three-lobed form, which is peculiar to the genus *Obolus* and is continued by the aberrant position of the places of attachment of the muscles.

The thickening of the posterior part of the large shell is reduced to a wall-like rim whose pointed upper edge incloses the parietal band. The declivity of this rim into the brachiocœle is quite steep and marked at its middle, circular-formed, projecting part by somewhat diverging longitudinal swellings palmately arranged; the slope into the splanchnocœle is flatter and is lost in the indefinitely bordered central groove, from which only the strongly drawn forth, parallel-bordered, somewhat anteriorly broadened, and rounded-off tip is clearly distinguishable by a slight but sharply bordered depression.

As often mentioned, the places of attachment of the middle lateral muscles, which are removed from the places of attachment of the central muscles, and united to one surface, lie before the tip of the central groove. The places of attachment of the central muscles are oval and lie on both sides of the drawn-out apex of the central groove. They show a coarse transverse striation, which is posteriorly continued farther than the places of attachment, and owes its origin to the gradual advance of the central muscles, whose traces were only partly covered by a slight secretion of lime. A similar condition takes place with the places of attachment of the outside lateral muscles of the large shell, which lie, as with *Schmidtia*, close to the inner sides of the principal vascular canal, far removed from those of the central muscles, and somewhat pushed back. Yet more striking is this succession of exposed traces with the places of attachment of the central muscles of the small shell, in which it may be followed from the inner sides of the corneous processes to the extreme tip of the sinus.

The last-mentioned small shell of the variety *solidus* shows very distinctly—namely, at the right side—the places of attachment of the combined middle and outside lateral muscles as well as those of the transmedian muscles, while the umbonal muscle has left less distinct traces. The first-mentioned places of attachment lie so close to the border of the shell that the pleurocœles are reduced to small, ribbon-shaped striæ. This form of the pleurocœle stands in connection with the previously mentioned law of growth of the shells.

In the large shell the places of attachment of the combined anterior lateral and transmedian muscles, likewise on the right side, are quite distinctly pronounced, while the places of attachment of the divided umbonal muscles and peduncular muscle form a somewhat indefinitely bordered, coherent surface, which is longitudinally striate in the middle.

Very striking to the eye is the strongly developed median swelling of the small shell, which separates the distinctly depressed oval places of attachment of the anterior lateral muscles, and reaches, with its pestle-shaped swelled ends, nearly to the anterior border of the shell; of the circulatory system only the posterior parts of the principal vessels (with the exit out of the splanchnocœle) are unfailingly distinguishable. The concentric striæ of the small shell are insufficiently covered furrows of separation of the growth lamellæ.

FORMATION AND LOCALITY.[a]—**Passage beds** between the Upper Cambrian and the Ordovician: "Glauconite sandstone" at the following localities: (**396**) at Baltischport, 30 miles (48 km.) west of Reval; (**396a**) *at Leppiko near Leetz, on the eastern side of the Baltischport peninsula, about 25 miles (40.3 km.) west of Reval;* (**396b**) at Fall, 15 miles (24 km.) west of Reval; (**396c**) at the mouth of Fähna Brook, east of Fall, about 15 miles (24 km.) west of Reval; (**396d**) at Domglint in Reval; and (**396f**) in the western part of the east Baltic region; all [Mickwitz, 1896, p. 203] in the Government of Esthonia, Russia.

Upper Cambrian: (**395**) *Obolus* sandstone at Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval, Government of Esthonia, Russia.

[a] Localities **395** and **396a** are represented in the United States National Museum collections.

LINGULEPIS Hall,[a] subgenus of LINGULELLA.

[Lingula, a tongue; and λεπίς, a scale.]

Lingulepis Hall, 1863, Sixteenth Ann. Rept. New York State Cab. Nat. Hist., p. 129. (Described as a new genus.)
Lingulepis Hall, Meek and Hayden, 1865, Smithsonian Contrib. Knowl., No. 172, Paleontology Upper Missouri, pt. 1, pp. 1 and 2. (Described and discussed.)
Lingulepis Hall, 1867, Trans. Albany Inst., vol. 5, p. 106. (Copied from Hall, 1863, p. 129.)
Lingulepis Hall, Dall, 1870, Am. Jour. Conchology, 2d ser., vol. 6, pt. 2, pp. 154 and 161. (Described.)
Lingulepis Hall, Meek, 1871, Proc. Acad. Nat. Sci. Philadelphia for 1871, vol. 23, pp. 186–187. (Notes on genus in discussion of "*Lingulella? lamborni.*")
Lingulepis Hall, Zittel, 1880, Handbuch der Palæontologie, Bd. 1, Abth. 1, p. 664. (Described in German.)
Lingula (*Lingulepis*) (Hall), Oehlert, 1887, Manuel de conchyliologie, by Fischer, p. 1261. (Described in French.)
Lingulepis Hall, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, pp. 231–232. (Described.)
Lingulepis Hall, Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, pp. 547–548. (Copy of preceding reference.)
Lingulepis Hall, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 59–62, and 164. (Original description copied, p. 59; genus described and discussed, pp. 59–62; and derivation of genus shown graphically, p. 164.)
Lingulepis Hall, Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 258. (*Lingulella* and *Lingulepis* compared.)
Lingulepis Hall, Walcott, 1897, Am. Jour. Sci., 4th ser., vol. 3, p. 404. (Re-refers all the species that have been placed under *Lingulepis*.)
Obolus (*Lingulepis*) (Hall), Walcott, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, pp. 443–444. (Copy of preceding reference, except that *Lingulepis* and *Lingulella* are made subgenera of *Obolus*.)
Obolus (*Lingulepis*) (Hall), Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 683. (Characterized.)
Lingulepis Hall, Matthew, 1902, Trans. Roy. Soc. Canada for 1902, 2d ser., vol. 8, sec. 4, No. 3, p. 102. (Discussed.)
Lingulepis Hall, Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 126. (Described and discussed. Hall's original description copied also.)
Lingulepis Hall, Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 193. (Characterized.)
Lingulella (*Lingulepis*) (Hall), Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 144. (Classification of subgenus.)

Genotype.—*Lingula acuminata* Conrad.

Schuchert states in his bibliography [1897, p. 258] that the only essential difference between *Lingulepis* and *Lingulella* is that the ventral beak of the former is often much attenuated. He does not refer to the interior markings of the valves, which have been illustrated as of a peculiar character by Hall [1892c, p. 60]. I quite agree with Schuchert, and I find that, with a fairly good series showing the interiors of both valves, all the essential markings of the vascular system and muscle scars are the same as in *Lingulella*, except as the form of the ventral valve changes the outline of the visceral area. When a shell of *Lingulella* (*Lingulepis*) *acuminata* (Conrad) (Pl. XLII, figs. 1g, 1h) is less attenuate than usual it is almost a good *Lingulella*, both as regards external form and interior markings. It is a fact, however, that many hundreds of specimens with a wide geographic distribution show a persistent form that is readily recognized, and for this reason, and also for convenience of classification, I give *Lingulepis* a subgeneric value.

[a] The synonymy for this subgenus does not give a complete record of the various genera under which the species now included in *Lingulepis* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Lingula Conrad [1839, p. 64].
Lingula Emmons [1842, p. 268].
Lingula Hall [1847, pp. 3 and 9; 1851, p. 204].
Lingula Owen [1851, p. 170; 1852, p. 583].
Orbicula Owen [1852, p. 583].
Lingula Emmons [1855, pp. 202 and 203].
Lingula Billings [1856, p. 34].
Lingula Hall [1862, pp. 21 and 435].
Lingula Hayden [1862, p. 73].
Lingula Billings [1863, p. 102].
Lingula Chapman [1863, p. 187].
Lingula Emmons [1863, p. 92].
Lingula Chapman [1864, p. 159].
Lingula Holl [1865, p. 102].
Lingula Salter [1865, p. 102].
Lingula Davidson [1866, pp. 41 and 53].
Lingula Phillips [1871, p. 68].
Lingulepis Whitfield [1880, pp. 335 and 337; 1882, p. 169; 1884, p. 141].
Lingulepis Dwight [1886, p. 208].
Lingulella Matthew [1891, p. 146].
Glossina Hall and Clarke [1892a, Pl. I, figs. 10 and 11].
Lingula (*Glossina*) Hall and Clarke [1892c, Pl. I figs. 1 and 2].
Lingula James [1895, p. 884].
Lingulepis Matthew [1895b, pp. 256 and 257].
Lingulepis Walcott [1897a, p. 404].
Lingulella Matthew [1899, p. 199].
Obolus (*Lingulepis*) Walcott [1901, p. 692].
Lingula Matley [1902, p. 141].
Obolus (*Lingulella*) Walcott [1902, p. 607].
Obolus (*Lingulepis*) Walcott [1905a, p. 333; 1906, p. 567].
Lingulella (*Lingulepis*) Walcott [1908d, p. 72].

The visceral area of *Obolus sinoe* (Pl. XXVI, fig. 2e) is somewhat like that of *Lingulella* (*Lingulepis*) *acuminata* (Pl. XLII, fig. 1g), and also resembles the visceral area of the ventral valve illustrated by Hall [1863, Pl. VI, fig. 15]. The condition of preservation and the original impress made by the different parts of the animal on the shell varies so much in shells of the same species that it is difficult, without a large series of specimens, to decide definitely upon generic or specific characters in the Obolidæ. This is particularly true of *Obolus*, *Lingulella*, and *Lingulepis*.

Of the 14 species and 2 varieties referred to *Lingulepis* from the Cambrian, 1 species occurs in the Lower Cambrian, 9 species and 2 varieties in the Middle Cambrian, and 5 in the Upper Cambrian. One species, *L.* (*L.*) *acuminata* (Conrad), is common to the Middle and Upper Cambrian and Ordovician.

For the species that have been referred to *Lingulepis* and which are now referred to other genera, see pages 62–63.

Lingulella (Lingulepis) acuminata (Conrad).[a]

Plate XXXIV, figures 3, 3a–e; Plate XL, figures 1, 1a–s; Plate XLI, figures 1, 1a–n; Plate XLII, figures 1, 1a–o.

Lingula acuminata Conrad, 1839, Third Ann. Rept. New York State Survey, p. 64. (Described as a new species.)

Lingula antiqua Emmons, 1842, Nat. Hist. New York, Geology, pt. 2, p. 268, fig. 68. (Occurrence discussed. Fig. 68 is copied in this monograph, Pl. XL, fig. 1a.)

Lingula antiqua Emmons, Hall, 1847, Nat. Hist. New York, Paleontology, vol. 1, pp. 3–4, Pl. I, figs. 3a–e. (Described and discussed as a new species, but uses Emmons's name.)

Lingula acuminata Conrad, Hall, 1847, idem, p. 9, figure with footnote. (Copies the original description of Conrad, 1839, p. 64. The figure is copied in this monograph, Pl. XL, fig. 1.)

Lingula prima Owen, 1851, Proc. Am. Assoc. Adv. Sci. for 1851, p. 170. (Mentioned.)

Lingula antiqua Emmons, Owen, 1851, idem, p. 170. (Mentioned.)

Lingula antiquata Emmons, 1855, American Geology, vol. I, pt. 2, pp. 202–203, Pl. IV, fig. 7. (Described and discussed. Fig. 7 is copied from Emmons, 1842, fig. 68, p. 268.)

Lingula acuminata Conrad, Emmons, 1855, idem, p. 203, Pl. IV, fig. 9. (Described. Fig. 9 is copied from Hall, 1847, p. 9, footnote.)

Lingula prima Owen, Billings, 1856, Canadian Naturalist, 1st ser., vol. 1, p. 34, fig. 1. (Described.)

Lingula antiqua Emmons, Billings, 1856, idem, p. 34, fig. 2. (Characterized.)

Lingula acuminata Conrad, Billings, 1863, Fifteenth Rept. Geol. Survey Canada, p. 102, figs. 8a–g. (Mentioned.)

Lingula acuminata Conrad, Chapman, 1863, Canadian Jour. Ind., Sci. and Art, new ser., vol. 8, p. 187, fig. 155. (Mentioned.)

Lingula antiqua Emmons, 1863, Manual of Geology, 2d ed., p. 92, fig. 77. (Mentioned. Fig. 77 is copied from Emmons, 1842, fig. 68, p. 268.)

Lingula acuminata Conrad, Chapman, 1864, Minerals and Geology of Canada, p. 159, fig. 155. (Text and figure copied from Chapman, 1863, p. 187, fig. 155.)

Lingulepis minima Whitfield, 1884, Bull. Am. Mus. Nat. Hist., vol. 1, No. 5, p. 141, Pl. XIV, figs. 1 and 2. (Described and discussed as a new species.)

Lingulepis minima Whitfield, Dwight, 1886, Proc. Am. Assoc. Adv. Sci. for 1885, p. 208. (Mentioned.)

Lingulepis acuminata Conrad, Dwight, 1886, idem, p. 208. (Mentioned.)

Lingula antiqua Emmons, James, 1895, Am. Naturalist, vol. 29, p. 884, fig. 1. (Mentioned. Fig. 1 is copied from Emmons, 1842, fig. 68, p. 268.)

Lingulepis acuminata (Conrad), Matthew, 1895, Trans. Roy. Soc. Canada for 1894, 2d ser., vol. 1, sec. 4, No, 13, pp. 257–258, Pl. II, figs. 5a–b. (Described and discussed.)

Lingulepis acuminata (Conrad), Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 259. (Discussed.)

Lingulepis acuminata (Conrad), Walcott, 1897, Am. Jour. Sci., 4th ser., vol. 3, p. 404. (Merely changes generic and specific references.)

Obolus (*Lingulepis*) *acuminatus* (Conrad), Walcott, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, p. 443. (Merely changes generic and specific references.)

Synonymy of the forms that have been referred to *Lingulepis pinnaformis* (Owen) from the Mississippi Valley, and which are now referred to *Lingulella* (*Lingulepis*) *acuminata* (Conrad):

Lingula prima Owen, Hall, 1851, Rept. Geology Lake Superior Land District, by Foster and Whitney, pt. 2, p. 204, Pl. XXIII, figs. 1a–g. (Described and discussed; dorsal valves.)

[a] The synonymy for this species is given in two parts; first, the synonymy of the forms that have been referred to the species *acuminata*; second, the synonymy of the forms that have been referred to the species *pinnaformis*. The latter species is now considered to be a synonym of the former.

Lingula antiqua Emmons, Hall, 1851, Rept. Geology Lake Snperior Land District, by Foster and Whitney, pt. 2, pp. 204–205, Pl. XXIII, figs. 2a–c. (Discussed; ventral valves.)

Lingula pinnaformis Owen, 1852, Rept. Geol. Survey Wisconsin, Iowa, and Minnesota, p. 583, Pl. I B, figs. 4, 6, and 8. (Described.)

Lingula antiqua Emmons, Hall, 1862, Rept. Geol. Survey Wisconsin, vol. 1, fig. 2, p. 21. (No text reference.)

Lingula pinnæformis Owen, Hall, 1862, idem, p. 435, fig. 3, p. 21. (Discussed.)

Lingula antiqua Emmons, Hayden, 1862, Am. Jour. Sci., 2d ser., vol. 33, p. 73, figs. 1a–b. (Discussed. It may be that the *Lingula prima* here mentioned by Hayden was based on the dorsal valves of *L. antiqua*.)

Lingulepis pinnaformis (Owen), Hall (in part), 1863, Sixteenth Rept. New York State Cab. Nat. Hist., pp. 129–130, Pl. VI, figs. 14–16 (not figs. 12 and 13, referred to *Obolus matinalis*). (Described and discussed.)

Lingulepis pinniformis (Owen), Meek and Hayden, 1865, Smithsonian Contrib. Knowl., No. 172, Paleontology Upper Missouri, pp. 2–3, Pl. I, figs. 1a–b. (Described and discussed.)

Lingulepis dakotensis Meek and Hayden, 1865, idem, p. 3. (Name merely proposed in case the species should prove distinct.)

Lingulepis pinnaformis (Owen), Hall (in part), 1867, Trans. Albany Inst., vol. 5, p. 107, Pl. I, figs. 14–16 (not figs. 12 and 13, referred to *Obolus matinalis*). (Copy of Hall, 1863, p. 129–130.)

Lingulepis pinnaformis (Owen), Whitfield, 1880, U. S. Geog. and Geol. Survey Rocky Mtn. Region, Rept. Geology and Resources Black Hills of Dakota, p. 335, Pl. II, figs. 1–4. (Described.)

Lingulepis dakotensis Meek and Hayden, Whitfield, 1880, idem, pp. 337–338, Pl. II, figs. 10 and 11. (Copies the description given by Meek and Hayden, 1865, p. 2, and discusses species. Figs. 10 and 11 are copied from Meek and Hayden, 1865, Pl. I, figs. 1b and 1a, respectively.)

Lingulepis pinnaformis (Owen), Whitfield, 1882, Geology of Wisconsin, vol. 4, pp. 169–170, Pl. I, figs. 2 and 3. (Described.)

Lingulepis pinniformis (Owen), Dwight, 1886, Proc. Am. Assoc. Adv. Sci. for 1885, p. 208. (Mentioned.)

Lingulepis pinniformis (Owen), Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, figs. 237 and 238, p. 232; and Pl. I, figs. 16 and 17. (Mentioned. Figs. 237 and 238 are outline drawings of the figures given by Hall, 1863, Pl. VI, figs. 16 and 15, respectively; figs. 16 and 17 (Pl. I) are copied from Hall, 1863, Pl. VI, figs. 16 and 15, respectively.)

Lingulepis pinniformis (Owen), Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, figs. 237 and 238, p. 548. (Mentioned. Figs. 237 and 238 are copied from those on p. 232 of the preceding reference.)

Lingulepis pinniformis (Owen), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, figs. 22 and 23, p. 60, and Pl. I, figs. 35 and 36. (Mentioned on pp. 60 and 61. Figs. 22 and 23 are outline drawings and figs. 35 and 36 are copies of the figures given by Hall, 1863, Pl. VI, figs. 16 and 15, respectively.)

Lingulepis pinniformis (Owen), Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 260. (Questions specific reference.)

Lingulepis pinniformis (Owen), Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 193, fig. 227. (Described. The two figures in figure 227 are copied from Hall, 1863, Pl. VI, figs. 15 and 16.)

Lingulepis prima (Hall), Grabau and Shimer, 1907, idem, p. 193. (Described, but no figures are given, and it is impossible to tell whether the species should be referred to *Lingulella* (*Lingulepis*) *acuminata* or to *Lingulella prima*.)

General form elongate ovate, with the ventral valve subacuminate to acuminate, and the dorsal valve ovate in outline. The outline of the valves varies greatly (Pl. XL). On a single slab of rock from Whitehall, New York, there is a range of variation that unites the slender acuminate form, represented by figure 1c, with forms that are not to be differentiated from *Lingulella acutangula* (Roemer). The range of variation in the dorsal valve is less, but it varies from elongate ovate to nearly round ovate. The convexity of the valves varies with the size and condition of preservation. Those that preserve the natural convexity are rather strongly convex in the dorsal valve, and about one-third less so for the associated ventral valve. The variation in size is very marked, large groups of shells occurring where the average length of the ventral valve is not over 6 to 10 mm. In other localities this increases to 20 mm. with corresponding increase in width.

Surface marked by concentric lines of growth, very fine concentric striæ, and fine radiating striæ. When the outer layer of the shell is exfoliated, the surface is marked by flattened, radiating striæ and concentric lines and striæ of growth. The inner surface is marked by flattened radiating striæ and minute pits or punctæ.

The shells from most localities are relatively thin, but some from the locality at St. Croix Falls show several layers, and those from the sandstones of the Black Hills of South

Dakota are relatively strong and thick. The shell is built up of a thin outer layer and several inner layers or lamellæ that, on the anterior and lateral portions of the shell, are oblique to the outer layer and form a thick, laminated shell very much like that of *Obolus*. Casts of the interior of the ventral valve show a clearly defined area that extends a considerable distance forward along the cardinal slopes. It is divided midway by a strong, rather broad pedicle furrow, and about midway of the very narrow side spaces, by extremely narrow flexure lines. One specimen from the Black Hills shows that the area formed a thin shelf between the pedicle groove and the lateral margins, the undercut extending some little distance beneath it. The area of the dorsal valve is clearly marked in a few specimens; it is relatively short although fairly well extended on the lateral margins.

The cast of the visceral cavity (v) is rarely preserved except in its posterior portion; this is marked by the cast of a median groove, and the path of advance of the central, anterior lateral, and middle lateral muscle scars. Traces of the muscle scars or the anterior portion of the visceral cavity are rarely preserved; thus the heart-shaped pit so often seen in *Lingulella* and *Obolus* is outlined in not over a half dozen specimens out of several hundred casts of the interior. The position and shape of the visceral area varies with the width of the shell. In the long shells it extends far forward, while in the broad shells it scarcely reaches to the center (Pl. XLII, figs. 1e and 1g.) No traces of a median septum have been observed in the ventral valve, but in the dorsal it is shown in the casts as a narrow, clearly defined, sharp depression, extending from between the anterior lateral scars back and between the central muscle scars.

The muscle scars are more or less clearly shown in a number of casts of both valves. The umbonal scar of the ventral valve is divided as in *Obolus*, the pedicle scar (m) (Pl. XLII, fig. 1g) being situated between the two parts (gg). In the dorsal valve the umbonal scar is situated just in front of the area, arching slightly toward the beak. The scars of the central, anterior lateral, and middle lateral muscles are not clearly defined in the ventral valve, owing to their being crowded together in the space on each side of the anterior portion of the visceral cavity.

The central muscle scars of the dorsal valve are of medium size and well defined on a number of casts of the interior of the shell. They are situated a little back of the center of the shell on each side of the median ridge, and their longer axis is slightly inclined outward. The anterior laterals are not well defined in the ventral valve, because they are crowded into a very narrow space. On the dorsal valve they are rarely visible, owing to their very faint impression on the shell. The transmedian scars are distinctly shown on the dorsal valve, but in the ventral valve they have not been differentiated from the anterior laterals.

The markings left on the shell by the vascular system are limited to the main or trunk sinuses on a few casts of the interior (Pl. XLI, fig. 1a, and Pl. XLII, fig. 1e).

Observations.—The type specimens described by Conrad [1839, p. 64] were small, and from an uncertain locality in the "Calciferous sandrock." His associate, Mr. Vanuxem, states [1842, p. 35] that Doctor Eights found a rolled stone containing *L. acuminata*, the surface of the fractured part showing from 60 to 70 valves in an area 2 by 3 inches.

I have collected this species *in situ* in great numbers in Saratoga County, and in the valley of the Hudson near Whitehall, in calcareous sandstones probably equivalent to Conrad's "Calciferous sandrock." The shell corresponds to the description given by Conrad, and occurs in great numbers in partings of the rocks.

In all of the illustrations given of this species from New York, the small, relatively narrow form was figured. The broader and larger form that occurs in the compact, sandy limestone north of Saratoga Springs, and at Beverly, Ontario, does not appear to have been known to the earlier authors.

It was not until 1863 that the Eastern forms so much like those of "*Lingula pinnaformis*" of Wisconsin were illustrated by Billings [1863, p. 102]. Matthew [1895b, Pl. II] illustrated the interior of the ventral and dorsal valves of *L.* (*L.*) *acuminata* from Beverly, Ontario. The muscle scars and their markings, as shown in Matthew's diagrammatic figures, vary from those

I have observed, and none of the specimens studied by him showed the area of either the ventral or dorsal valve.

As the result of a comparison of a series of specimens of *L.* (*L.*) *acuminata* from the Potsdam sandstone and the base of the "Calciferous" in Saratoga, Washington, Franklin, and Jefferson counties, New York, and from the same horizon in Ontario, Canada, with a large series of specimens from the "St. Croix sandstone" of Wisconsin, I was led [1897a, p. 404] to conclude that "*Lingula pinnaformis*" Owen was a synonym of *Lingulella* (*Lingulepis*) *acuminata* (Conrad), thus making *L.* (*L.*) *acuminata* the type of the subgenus *Lingulepis*, the original description of the subgenus being based upon specimens from the "St. Croix sandstone" of Wisconsin.

It is hardly practicable to illustrate all of the varieties of *L.* (*L.*) *acuminata* (Conrad) as they occur in widely distributed localities. The shells appear to have varied in size, thickness, convexity, and outline at various localities, and often in the same locality in different layers, probably owing to the character of food supply and the vitality of the individual animals. Very fine specimens of the casts of young shells of the narrow, elongate form occur at Mount Washington, Eau Claire, Wisconsin.

The species ranges from western Vermont, New York, and eastern Canada, westward across the upper Mississippi Valley to the Black Hills of South Dakota, the Bighorn Mountains of Wyoming, and the Rocky Mountains of central Colorado. In the Appalachian region it ranges southward to Tennessee and Alabama, and westward to the Arbuckle and Wichita mountains of Oklahoma, and the Franklin Range near El Paso, Texas. Its vertical range appears to have been from the upper portion of the Middle Cambrian in the Mississippi Valley and the Black Hills to the lower layers of the "Calciferous" of the Ordovician in New York and Canada.

A number of shells from the Upper Cambrian rocks of Nevada come within the rather wide range of variation of this species. I was at first inclined to place them as a variety, but after extended comparison with a series of specimens from New York and Wisconsin, decided that nothing would be gained by so doing. A few figures on Plate XXXIV, figures 4, 4a–e, illustrate the wide variation in form of the Nevada shell, a variation comparable with that from the typical locality in New York.

A fine series of specimens illustrating the narrow and broad forms has been collected from the limestone in the upper portion of the Reagan sandstone (Upper Cambrian), at the northwest extremity of the Arbuckle Mountains, Oklahoma.

Dwight [1886, p. 208], in speaking of the Upper Cambrian fauna near Poughkeepsie, New York, said:

> It will be observed, as has been suggested to me by Whitfield, that the fauna of this locality forms a connecting link between the Potsdam fossils of the Appalachian region and that of the more western States. Thus, the *Lingulella pinnaformis* of Wisconsin and other western localities is here mingled with *Lingulepis minima* and *acuminata* of New York State.

Dwight's remark that the species "*Lingulella pinnaformis*" occurs mingled with "*Lingulepis minima*" and "*L. acuminata*" proves that all the varieties of *Lingulella* (*Lingulepis*) *acuminata* occur at the Dutchess County locality.

FORMATION AND LOCALITY.—**Ordovician and Upper Cambrian:** (**338u**) Strata from the upper layers of the Potsdam sandstone to the lower portion of the "Calciferous sandrock" at Chateaugay Falls, Franklin County, New York.

Upper Cambrian: (**392e** [Billings, 1856, p. 34]) Sandstone on lot 22, ninth concession, township of Bastard; (**392d** [Billings, 1856, p. 34]) sandstone on lot 11, eleventh concession, township of Lansdowne; and (**392b** [Matthew, 1895b, p. 258]) sandstone (corresponding to the passage beds above the massive Potsdam sandstone at Chateaugay Falls) at Beverly, township of Bastard; all in the county of Leeds, Ontario, Canada.

(**392**) Potsdam sandstone at Burgess; (**392m**) sandstone on the east shore of Missisquoi Bay, 1.5 miles (2.4 km.) south of Phillipsburgh, Province of Quebec; and (**392n**) sandstone in eastern Canada (exact locality unknown); all in Canada.

(**16n**) Interformational conglomerates and shales in Adams pasture, 0.5 mile (0.8 km.) west of Main Street, on Lake Street, St. Albans, Franklin County, Vermont.

(**76**) Arenaceous limestone at Hoyt's quarry, 4 miles (6.4 km.) west of Saratoga Springs, Saratoga County; (**76a**) arenaceous limestone in a railroad quarry 1 mile (1.6 km.) north of Saratoga Springs, Saratoga County; (**109**) sandstone 25 feet (7.6 m.) above the Archean, 1.5 miles (2.4 km.) south of Deweys Bridge, on the Champlain Canal, Washington

County; (367k) sandstone at Deweys Bridge, Washington County; (110 and 110a) shaly calcareous sandstone resting on massive layers of Potsdam sandstone, east side of the town of Whitehall, Washington County; (338r [Billings, 1856, p. 34]) Potsdam sandstone at Keeseville, Essex County; (338s [*Emmons, 1842, pp. 267 and 268*]) *Potsdam sandstone at High Bridge, on Ausable River, Essex County;* (77) sandstone at several horizons in the section below the falls at the high bridge, in Ausable Chasm, Essex County; (111) at the top of the Potsdam sandstone on Marble River, 1 mile (1.6 km.) south of Chateaugay, Franklin County; (338t) Potsdam sandstone in Ausable Chasm, below Keeseville, Essex County; (338w [Hall, 1847, p. 4]) Potsdam sandstone at Hammond, St. Lawrence County; (338j [Hall, 1847, p. 4]) Potsdam sandstone near Alexandria Bay, Jefferson County; (185) sandy layers above the massive Potsdam sandstone one-half mile (0.8 km.) southeast of Redwood, Jefferson County; (185a) sandy layers 20 feet above the massive Potsdam sandstone, east side of Indian View, 3 miles (4.8 km.) south of Theresa, Jefferson County; (367j) sandstone 3 miles (4.8 km.) south of Poughkeepsie, Dutchess County; (108) sandstone 1 mile (1.6 km.) south of Poughkeepsie, Dutchess County; and (367e [Dwight, 1886, p. 205]) shaly limestones 850 feet (259.1 m.) southerly from the southwest corner of the driving park and 2,200 feet (670.6 m.) west of the road leading southerly from the same, about 1 mile (1.6 km.) southwest of Vassar College, near Poughkeepsie, Dutchess County; all in New York.

(92b) Limestone on Buffalo Creek, 2 miles (3.2 km.) southeast of Buffalo Mills, Rockbridge County, Virginia.

(105) Limestone in Knox dolomite, at Bishops Mill, Hancock County; and (107o) limestones and shales at the base of the Knox dolomite, west of the top of Copper Ridge, near the Southern Railway cut, about 10 miles (16.1 km.) northwest of Knoxville [Keith 1896b, areal geology sheet], Knox County; both in Tennessee.

(79 and 79b) "St. Croix sandstone" near Hudson, St. Croix County; (82 and 82s) "St. Croix sandstone" on the bank of St. Croix River, St. Croix Falls, Polk County; (328h) silicocalcareous layers of F1b of Owen, at the falls of the St. Croix, Polk County; (97a) "St. Croix sandstone" near Winfield, Jefferson County; (98) "St. Croix sandstone" near Eau Claire, Eau Claire County; and (99a) "St. Croix sandstone" near Pilot Knob, Adams County; all in Wisconsin.

(330 [Hall, 1851, p. 204]) Sandstone on Taquamenon Bay, Chippewa County; (330b) sandstone at Iron Mountain, Dickinson County; and (330a [Hall, 1851, p. 204]) sandstone on Escanaba River; all in northern Michigan.

(339h [Hall, 1863, p. 130]) "St. Croix sandstone" near the mouth of the Minneiska (Miniska) River, near the line between Wabasha and Winona counties; and (97b) "St. Croix sandstone" below the greensand bed and about 25 feet above St. Croix River at Franconia, Chisago County; both in Minnesota.

(353b) Sandstone just beneath the *Ophileta* zone, south end of the Franklin Range, El Paso County, Texas.

(360g) Shaly sandstone on Trout Creek, 1 mile (1.6 km.) below Manitou Park, El Paso County, Colorado.

(54d) About 1,050 feet (320 m.) above the Middle Cambrian and 175 feet (53.3 m.) below the top of the Upper Cambrian in the lower part of the limestone forming 1 of the St. Charles formation [Walcott, 1908f, p. 192]; and (54g) just above the Middle Cambrian, near the base of the bedded light-gray sandstone forming 4 of the St. Charles formation [Walcott, 1908f, p. 193]; both in Blacksmith Fork Canyon about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

(7x and 7y) Limestone of the Emigrant formation [Turner, 1902, p. 265], about 2.5 miles (4 km.) southeast of Emigrant Pass; and (7z) limestone of the Emigrant formation [Turner, 1902, p. 265], about 3 miles (4.8 km.) southeast of Emigrant Pass; both in the Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County, Nevada.

(9q) About 10 feet (3 m.) above the porphyry contact and 90 feet (27.4 m.) below the Arbuckle limestone in limestone of the Reagan sandstone, middle of west half of sec. 2, T. 4 N., R. 13 W., about 15 miles (24.2 km.) northwest of Fort Sill, Comanche County; (9s) about 85 feet (26 m.) below the Arbuckle limestone in the limestone of the Reagan sandstone, near middle of west half of sec. 13, T. 4 N., R. 13 W., 13 miles (20.8 km.) northwest of Fort Sill, Comanche County; (9v) limestone of the Reagan sandstone, about 250 feet (76 m.) below the Arbuckle limestone, SW. ¼ sec. 17, T. 4 N., R. 12 W., about 11 miles (17.7 km.) northwest of Fort Sill, Comanche County; (12n) limestone of the Reagan sandstone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 240 feet (73 m.) above the porphyry contact and 40 feet (12 m.) below the Arbuckle limestone), NW. ¼ sec. 1, T. 2 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County; and (12p) about 225 feet (69 m.) above the igneous rocks in the limestone of the Reagan sandstone, at the northwest extremity of the Arbuckle Mountains, about 4 miles (6.4 km.) east of Homer, Carter County; all in Oklahoma.

(14b) Limestone on Cold Creek at north end of gorge opposite the north end of Sponge Mountain, 2 miles (3.2 km.) south of the San Saba County line in Llano County; (14r) sandstone in the lower part of the beds exposed on Colorado River, 3 miles (4.8 km.) south of the northeast corner of Llano County; (69) limestone near Honey Creek, Burnet County; and (70) limestone near Morgans Creek, Burnet County; all in Texas.

Middle Cambrian: (328e) "St. Croix sandstone" at St. Croix Falls, Polk County; and (79x) "St. Croix sandstone" near the flour mill on Beaver Creek, north of Galesville, Trempealeau County; both in Wisconsin.

(84) "St. Croix sandstone" at Dresbach, opposite the mouth of Black River, Winona County; (84s) "St. Croix sandstone" near Dakota, Winona County; (339j) sandstone between the lowest blue shale and the reddish calcareous beds above, at Taylors Falls, Chisago County; and (339k) sandstone near Winona, Winona County; all in Minnesota.

(89) Limestone in Murphrees Valley, Blount County, Alabama.

(374d) Shale 2 miles (3.2 km.) north of Rotherwood; and (124a) shale (Nolichucky?) overlying the limestone which rests on the Rogersville shale, on Big Creek, southeast of Harlan Knob, 4 miles (6.4 km.) northeast of Rogersville [Keith, 1905, p. 4, and areal geology sheet]; both in Hawkins County, Tennessee.

(355) Sandstones on Red Canyon Creek, southwest side of Black Hills; (355d) sandstone in the Black Hills; (164) sandstone in the Deadwood formation in the cliffs on the east side of the valley near Deadwood, Black Hills; (167) sandstone beneath limestone and resting on the pre-Cambrian in a bluff 9 miles (14.4 km.) west of Custer, Black Hills; and (355b) sandstone in the Deadwood formation on Castle Creek, west side of Black Hills; all in South Dakota.

(171 and 171a) Sandstone in Big Goose Creek Canyon, Bighorn Mountains, west of Sheridan, Sheridan County; (302m) middle of shale above lower sandstone on Billy Creek, in the Bighorn Mountains, Sheridan County; and (340c) dark-red sandstone near the base of the Cambrian at Rawlins, Carbon County; all in Wyoming.

Lingulella (Lingulepis) acuminata meeki (Walcott).

Plate XLI, figures 2, 2a.

Lingulepis meeki Walcott, 1897, Am. Jour. Sci., 4th ser., vol. 3, p. 405. (Described and discussed as below as a new species.)

Obolus (*Lingulepis*) *acuminatus meeki* Walcott, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, p. 444, Pl. LX, figs. 1 and 1a. (Text copied from preceding reference. The specimens represented by figs. 1 and 1a are redrawn in this monograph, Pl. XLI, figs. 2 and 2a, respectively.)

Obolus (*Lingulepis*) *acuminata weeksi* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 333. (Merely used for *Obolus* (*Lingulepis*) *acuminata meeki* by mistake in discussion of "*Obolus* (*Lingulepis*) *eros.*")

Shell small, attenuate, marked by rather strong concentric lines and striæ of growth, and interrupted, irregular, radiating striæ.

Ventral valve narrow, elongate, beak acuminate, rostral slopes long, nearly straight, passing gradually into the curvature of the anterolateral margins, and posteriorly meeting at a very acute angle; front strongly rounded. Length of valve, 8 mm.; width, 3.5 mm., the widest portion being near the anterior extremity. Beak slightly upcurved, the longitudinal median line straight or even slightly concave from the apex of the beak to the middle, where it begins to slope gently to the frontal margin; transverse curvature very slight anteriorly, more convex than the beak.

Dorsal valve more convex than the ventral, linguliform; beak depressed, bluntly rounded, curving evenly and gradually to the semitruncate anterior margin.

Observations.—The interior markings of this shell have not been ascertained, but the external characters are such as to make a reference to the subgenus *Lingulepis* more than probably correct. The flat, acute-acuminate ventral valve with its elevated or retrorse beak, which is not covered by the smaller dorsal valve, is characteristic of *Lingulepis*.

There is a form from Texas, probably identical with *Lingulella perattenuata* (Whitfield) that might be mistaken for this variety, but it is an undoubted *Lingulella* and does not show the external characteristics of *Lingulepis*. A comparison of *Lingulella* (*Lingulepis*) *acuminata meeki* with the young and narrow specimens of *L.* (*L.*) *acuminata* (Conrad) shows it to vary from that species, the posterior rostral slopes of *L.* (*L.*) *acuminata* possessing a peculiar incurving which is not shown in *L.* (*L.*) *acuminata meeki*.

After the publication of "*Lingulepis meeki*" [Walcott, 1897, p. 405] shells were collected from the north end of the Teton Range, which showed that that form was very closely related to *L.* (*L.*) *acuminata*. As all the Teton Range shells were quite small and the majority had the characters of "*Lingulepis meeki*," the latter was reduced to a variety of *L.* (*L.*) *acuminata* [Walcott, 1899, Pl. LX, figs. 1 and 1a], and the Teton shells were included with those from the Gallatin Range.

The varietal name was given in honor of Dr. F. B. Meek.

Formation and locality.—**Middle Cambrian:** (302b) *Limestones near Crowfoot Ridge, Gallatin quadrangle* (*U. S. Geol. Survey*), *Yellowstone National Park;* and (4e) limestones about 950 feet (289.6 m.) above the unconformable base of the Cambrian in the divide at the head of Jackson Creek (locally known as Sheep Creek), a creek flowing into Jackson Lake about 0.5 mile (0.8 km.) south of its northwest corner, Teton Mountains, Grand Teton quadrangle (U. S. Geol. Survey), Uinta County; both in Wyoming.

(4h) About 375 feet (114.3 m.) above the base of the Cambrian in limestone interbedded in the Flathead shales of Peale [1893, p. 21], 1 mile (1.6 km.) north of the junction of East Gallatin and West Gallatin (Gallatin) rivers, 4 miles (6.4 km.) east-northeast of Logan, Threeforks quadrangle (U. S. Geol. Survey), Gallatin County, Montana.

Lingulella (Lingulepis) acuminata sequens Walcott.

Text figures 46A–B.

Glossina acuminata Hall and Clarke [not Conrad], 1892, Eleventh Ann. Rept. State Geologist New York for 1891, Pl. I, figs. 10 and 11. (No text reference.)

Lingula (Glossina) acuminata Hall and Clarke [not (Conrad)], 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, Pl. I, figs. 1 and 2. (No text reference. Figs. 1 and 2 are copied from Hall and Clarke, 1892a, Pl. I, figs. 10 and 11, respectfully.)

Lingulella (Lingulepis) acuminata sequens Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 72, Pl. VIII, fig. 4. (Characterized and discussed as a new variety. Fig. 4 is copied in this monograph as fig. 46A.)

This variety differs from *Lingulella (Lingulepis) acuminata* (Conrad) in being somewhat less attenuate in its ventral valve, and in having the cardinal slope of the ventral valve straight, instead of gently incurved.

It occurs at a slightly higher geologic horizon than *L. (L.) acuminata*, and appears to be a form derived from that species.

Judging from Hall and Clarke's illustrations [1892a, Pl. I, figs. 10 and 11] they had representatives of this variety of *Lingulella (Lingulepis) acuminata* and mistook them for the form illustrated by Hall [1847, p. 9] as *Lingula acuminata*. That figure represents a typical form of *L. (L.) acuminata*, and is not the variety illustrated by Hall and Clarke in 1892.

The specimens illustrated by Hall and Clarke are given as from Saratoga County, New York, "Calciferous sandstone." The specimens which I have taken as typical of this variety are from Division A of the Beekmantown limestone.

This form owes its varietal name to the fact that it is a later representative of the species.

Formation and locality.—**Ordovician:** (**367c**) Beekmantown limestone, Division A; quarry near the northwest suburb of Ticonderoga, Essex County, New York.

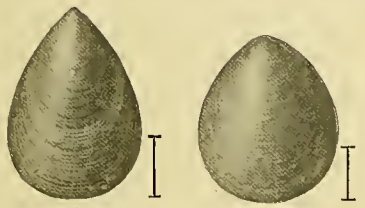

Figure 46.—*Lingulella (Lingulepis) acuminata sequens* Walcott. A, Ventral valve showing nearly straight lateral slopes (U. S. Nat. Mus. Cat. No. 53675a). B, Dorsal valve (U. S. Nat. Mus. Cat. No. 53675b).

The specimens represented are from Locality **367c** near Ticonderoga, New York. Fig. 46A is copied from Walcott [1908d, Pl. VIII, fig. 4]. It represents the type specimen.

Lingulella (Lingulepis) eros (Walcott).

Plate XXXIX, figures 9 and 9a.

Obolus (Lingulepis) eros Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 333. (Described and discussed as below as a new species.)

Ventral valve elongate with rostral slopes gradually converging so as to form an acuminate beak. Surface marked by fine concentric lines of growth and very fine, somewhat irregular, concentric striæ. Rather large scattered punctæ occur on the interior surface.

This species is represented by fragments and two broken ventral valves; these indicate a length for the ventral valve of from 7 to 10 mm. It is allied to *Lingulella (Lingulepis) acuminata meeki* [a] (Walcott) of the Middle Cambrian fauna of the Teton mountains of Wyoming.

Formation and locality.—**Middle Cambrian:** (**C7**) Lower limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 39 (last list of fossils), and fig. 8a (bed 33), p. 29], 2.2 miles (3.5 km.) southwest of Yenchuang, Sintai district, Shantung, China.

Linguella (Lingulepis) exigua (Matthew).

Plate XXXIII, figures 4, 4a; Plate XLIII, figures 1, 1a–z.

Obolus (Lingulepis) gregwa Walcott (in part) [not (Matthew)], 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 692–694. (Described and discussed almost as on pp. 552–553, with the exception of the notes under "*Observations*," which have been rewritten in this monograph. The following species were included in this reference: *Lingulella (Lingulepis) exigua*, *L. (L.) gregwa*, *Lingulella tumida*, and *L. atava*.)

[a] Written "*weeksi*" in the original description [Walcott, 1905a, p. 333] through mistake.

Lingulepis starri var. MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 193–197, Pl. XIV, figs. 2a–e. (Gives an essential copy (rearranged) of the description given by Walcott, 1901, pp. 692–694, and describes and discusses the specimens referred by Walcott to *Obolus* (*Lingulepis*) *gregwa* as belonging to an undetermined variety of Matthew's "*Lingulepis starri*.")

Lingulepis starri exigua MATTHEW, 1903, idem, pp. 197–198, Pl. XIV, figs. 3a–d. (Described and discussed as a new variety.)

General form elongate ovate with the ventral valve acuminate and the dorsal valve ovate triangular in outline. The outline of the valves varies, as shown by the series of figures on Plate XLIII and by many other specimens not illustrated. The convexity of the valves varies with the condition of the preservation, those from the sandstone being rather strongly convex, while those in the shale are very much compressed. On the dorsal valve of the youngest shells there is a marked and rather broad, shallow sinus extending from the umbo to the front where it flattens out.

One of the largest ventral valves has a length of 21 mm., with a width of 18 mm. A dorsal valve 16 mm. in width has the same length; other examples are a little wider than long.

Surface of the shell marked by concentric striæ and undulations of growth, over which there is a series of very fine, elevated, sharply undulating and inosculating lines that form a minute irregular network over the surface, very much like that of *Lingulella* (*Lingulepis*) *gregwa* (Matthew), except that the irregular lines are very much finer on the latter. Where the lines are strongly elevated the effect is that of a minutely granulose surface. In some examples the surface suggests an incrusting or scabrous outer layer of shell covered with minute points. When the thin outer layer of the shell is exfoliated the surface of the various bright, shiny, inner layers is minutely granulose, in addition to the flattened, radiating striæ and concentric lines of growth. The interior surface of both valves is often marked by concentric rows of strong pits or punctæ very much as in *Lingulella davisi* (McCoy) (Pl. XXXI, fig. 6g). In some specimens the lines of punctæ extend over the surface of the visceral cavity so as to obscure the vascular markings and muscle scars. In some examples only a few scattered punctæ occur, while in others they are present over nearly the entire surface. The small shells are thin, but the larger ones are built up of a very thin outer layer and several inner layers or lamellæ that are more or less oblique to the outer surface, especially over the anterior and lateral portions of the shell.

The plane of the cardinal area of the ventral valve is nearly coincident, near its edges, with the edge of the shell. The area is long and extends well forward on the cardinal slope. It is divided midway by a narrow, rounded, deep pedicle furrow, and about half way between the pedicle furrow and the lateral margins by an unusually well-defined flexure line which is in line with the main vascular furrows of the interior of the valves; fine striæ of growth cross the area and arch around the pedicle furrow parallel to the base of the area. There is practically no undercut beneath the area except near the flexure line at the frontal margin of the area. The area of the dorsal valve is short, narrow, and crossed by fine lines of growth parallel to its base.

The cast of the visceral cavity in the ventral valve shows it to have been relatively small and usually confined to the posterior half of the shell, although in some shells it extends past the center (Pl. XLIII, fig. 1q). There are no traces of a median septum in the ventral valve; in the dorsal valve, at the bottom of the groove between the central muscle scars, there is a slightly elevated median line that extends forward to the anterior margin of the visceral cavity beyond the anterior lateral muscle scars. The visceral cavity of the dorsal valve usually extends forward to about the center of the valve, but in a series of specimens collected in 1903 a number of interior casts show the front of the visceral area varying in position from back of the center to nearly the frontal margin of the shell; it varies in width and outline very much as the shells vary, being wide in broad shells and narrow in elongate forms.

The markings left on the shell by the vascular system are very strong and beautifully preserved in some portions. The direction and size of the main sinuses are well shown by the illustrations; in some shells there is a double groove with a slight ridge between; in others the

ridge is large, only a trace of an outer groove remaining; in some young shells the groove is broad and shallow; in all shells the large size of the main vessels is shown by the broad, strong grooves or ridges left on the shell. It frequently happens that the lines of sharply defined pits on the lines of growth deeply indent the grooves and rounded ridges left by the main vessels and mark them off into sections. The interior and lateral vessels left narrow but strong grooves or ridges on the shell, which, however, are usually obscured by the strong pitting of the surface. The parietal scar surrounds the visceral cavity in each valve, crosses the course of the main vascular vessels, and comes back around the spaces occupied by the muscle scars, terminating at the edge of the area at the flexure line in the ventral valve; termination unknown on the dorsal valve.

Some of the muscle scars are finely shown in the dorsal valve and fairly well in the ventral. The umbonal scar of the ventral valve is divided, the pedicle scar being situated between the two parts. In the dorsal valve the umbonal scar is close to the area, and extends nearly as far each side of the median line as the length of the area.

The scars of the central muscles in the ventral valve are crowded in with the middle and outside laterals within the trapezoidal space (c, Pl. XLIII, figs. 1q and 1s). In the dorsal valve they are located on a low ridge each side of a central, longitudinal median depression; they are elongate oval in outline, their major axis being subparallel to the median line of the shell; fine longitudinal lines cross the scars in the best preserved specimens; the ridge on which the central scars occur varies in strength, but it appears to be present in all adult shells; it narrows gradually posteriorly and rather rapidly to the inner side of the anterior lateral muscle scars. The anterior laterals of the ventral valve are placed well back on the narrow space between the edge of the area and the main vascular sinus; they are elongate and rather large; in the dorsal valve they are elongate with the major axis inclining toward the median line (Pl. XLIII, figs. 1r and 1y). The middle and outside laterals are situated in the trapezoidal area (c) of the ventral valve, but neither is clearly separable from the other or from the central scars. In the dorsal valve the position of the middle and outside laterals is shown, but not their form or size. The transmedian scars in the ventral valve are seen just back of the anterior laterals, but they have not been observed in the dorsal valve owing to the imperfections of the shell.

Observations.—This is one of the most interesting species of *Lingulepis* I have known. In its coarsely pitted inner surface it recalls *Lingulella davisi* (McCoy) (Pl. XXXI) of England, and *Obolus willisi* (Walcott) (Pl. XXIII) of the southern Appalachians. The elongate ventral valve is like that of *Lingulella* (*Lingulepis*) *acuminata* (Conrad), while the interior scars and markings are those of *Obolus*. With *L.* (*L.*) *gregwa* (Matthew) and *L.* (*L.*) *starri* (Matthew) it is the Atlantic coast representative of *L.* (*L.*) *acuminata* which is so abundant in the Middle Cambrian of the Upper Mississippi Valley, and in the passage beds between the Cambrian and the Ordovician in the region adjoining the Adirondack Mountains of New York. It differs from *L.* (*L.*) *acuminata* in its surface characters.

The shells embedded in the fine-grained shales are all flattened and more or less distorted by compression, while those in the sandy layers interbedded in the shales retain their original convexity, although frequently distorted and fractured by movement of the matrix. The fracturing of the brittle, mineralized shell is beautifully illustrated by Plate XXXIII, figure 4a, which represents the siliceous fillings of the fractures, the shell substance having been dissolved with acid.

Typical specimens of *Lingulella* (*Lingulepis*) *exigua* have narrow, elongate ventral valves and broadly oval dorsal valves. I was at first strongly inclined to separate the broad, thick shells as a distinct species, but on finding a series of connecting forms and observing that the surface and interior markings were similar, I decided to unite them. The shells vary materially in their external aspect in the different layers of siliceous rock, but when the shell substance is removed by acid it is found that their interior and exterior characters are the same. The typical forms of *L.* (*L.*) *exigua* are represented in Plate XLIII, by figures 1, 1a–b, 1d, 1g–j, and the variations

by figures 1f, 1o–s. With growth in size and age the shell increases in thickness notably over the posterior portions.

In some notes [1901, p. 692] on "*Lingulepis gregwa*" (Matthew), I identified this shell as "*Obolus* (*Lingulepis*) *gregwa*." It is closely related to it but differs in the surface characters. The exterior shell of *Lingulella* (*Lingulepis*) *gregwa* is marked by fine, irregular, elevated, and sometimes inosculating ridges that have a row of minute tubercles on them that give a beaded appearance to each ridge. The surface of the shell of *L.* (*L.*) *exigua* has a much more minutely granulose surface formed by very irregular, inosculating, elevated lines or ridges, much like that of *L.* (*L.*) *roberti* (Matthew).

Matthew [1903, p. 193] refers this form to "*Lingulepis starri* var." With the types of *starri* as a basis of comparison I find that the type of surface of *starri* is as stated by Matthew [1891, p. 147]: "Each valve is ornamented by numerous, concentric furrows, closely set, about 12 to 15 to a millimeter." I find 8 to 10 on one of the typical specimens. This surface is quite unlike the surface of *L.* (*L.*) *exigua* which is as described above. When the thin outer layer is exfoliated the concentric striæ and ridges of growth are like the surface of *starri*, but the outer surface is roughened ("granulated," Matthew) in a manner unlike the surface of *L.* (*L.*) *exigua*. It has the appearance under a strong magnifier of a surface produced by fine points distributed over an incrusting layer of shell.

Formation and locality.—**Upper Cambrian**: (**3n**) Thin-bedded sandstone on Salmon River, Gillis Hill, 13 miles (20.9 km.) south of Marion Bridge, eastern Cape Breton, Nova Scotia.

Middle Cambrian: (**3i**) *Compact, fine-grained, thin-bedded, gray sandstone of the Paradoxides zone [horizon of Division C2b, Matthew, 1903, p. 195], on McLean Brook, 1 mile (1.6 km.) east of McCodrum Brook and 1.5 miles (2.4 km.) west of Marion Bridge;* (**10s** and **10t**) sandstone on McLean Brook, near Marion Bridge; (**307f** [Matthew, 1903, p. 198]) shale of Division C2a on McLean Brook, Mira River; (**307g** [Matthew, 1903, pp. 195 and 198]) shales of Division C2b on McLean Brook, Mira River; (**13r**) sandstone of the "Johannian" Division of Matthew's section on Gillis Brook, East Bay, east of Bras d'Or Lake; and (**11z**) sandstone on Big Ridge, 2 miles (3.2 km.) south of Marion Bridge, on the canal of John McDougald; all in eastern Cape Breton, Nova Scotia.

Lingulella (Lingulepis) gregwa (Matthew).

Plate XLIV, figures 1, 1a–p.

Lingulella gregwa Matthew, 1899, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pp. 199–200, Pl. I, figs. 1a–f. (Described and discussed as a new species.)

Obolus (*Lingulepis*) *gregwa* Walcott (in part), 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 692–694. (The following species were included under *Lingulella* (*Lingulepis*) *gregwa* in this reference; *Lingulella* (*Lingulepis*) *exigua*, *L.* (*L.*) *gregwa*, *Lingulella tumida*, and *L. atava*. The specimens upon which the description was based are now referred to *Lingulella* (*Lingulepis*) *exigua*.

Lingulepis gregwa Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 56–57. (Notes on orientation of shells.)

Lingulepis gregwa Matthew, 1903, idem, pp. 126–131, Pl. IX, figs. 3a–f. (Described and discussed. Figs. 3a–f are copied from Matthew, 1899, Pl. I, figs. 1a–f.)

The description of *Lingulella* (*Lingulepis*) *exigua* (Matthew) applies very closely to this species, with the exception of the surface characters and details of outline, and the interior markings of the valves. As a whole, the ventral valve of *L.* (*L.*) *gregwa* is less acuminate, and the outline of the dorsal valve is more rounded posteriorly. A comparison of the series of illustrations of the two species fully exhibits the differences referred to. The exterior surface of the shell of *L.* (*L.*) *gregwa* is marked by a few, strong, concentric lines of growth, and numerous fine, concentric, irregular, often inosculating ridges having a row of minute tubercles on them that gives a beaded appearance to each ridge. This appearance is unmistakable when the outer shell is at all well preserved. There are also indications of very fine radiating ridges, irregularly dispersed over the surface of the shell. When the thin, highly ornamented outer layer is exfoliated the various lamellæ of the shell show very fine, radiating striæ, and a few concentric lines of growth. The interior of the shell has rather large scattered punctæ, and occasionally a specimen shows the punctæ gathered in concentric lines. The shell is built up of a thin outer layer and several inner layers, or lamellæ, that are more or less oblique to the

outer surface, especially over the anterior and lateral portions of the shell, where they are much more numerous. In many specimens the shell substance has been replaced by calcite.

Interiors of the ventral valve show considerable difference in the position of the main vascular sinuses. They are usually well out toward the sides. In the dorsal valve the main vascular sinuses are widely separated, and the visceral area is well extended toward the front.

Observations.—When studying the collections made by S. Ward Loper on McLean Brook in 1900, I identified the shells now placed under *Lingulella* (*Lingulepis*) *exigua* as "*Obolus* (*Lingulepis*) *gregwa*." But at that time I had only the somewhat imperfect material in Matthew's collection from Dugald Brook for the purposes of comparison. With a large series of well-preserved specimens collected on Dugald Brook in 1901 by Loper, the fact that the two species had been confused became at once apparent. *Lingulella* (*Lingulepis*) *gregwa* is found in great numbers at a lower stratigraphic horizon beneath the *Paradoxides* zone, while *L.* (*L.*) *exigua* occurs at the summit of the Middle Cambrian fauna in association with *Paradoxides*. Both species have strong points of resemblance to *L.* (*L.*) *acuminata* (Conrad) and both, in their younger stages, depart to such an extent from the typical forms of the adult shell that they might be considered a distinct species if found at another locality or stratigraphic horizon.

The specific name is derived from Gregwa Brook, on which specimens of the species occur.

Formation and locality.—**Middle Cambrian:** (**10p**) Sandstone just below the waterfall in Division E2b of Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River; (**10p′**) sandstone one-fourth mile (0.4 km.) from lower bridge, on Gregwa Brook, Indian River; (**10p″**) sandstone on the small brook on the hill between the bridge over Indian River and McPhees Brook; (**13t″**) sandstones of Divisions E1c and E1d of Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River; (**344e** [Matthew, 1903, p. 78]) shales of Division E1d of Matthew's [1903, pp. 28 and 29] Etcheminian, on Boundary Brook, eastern side of the Escasonie Indian Reservation; (**344k**[a] [Matthew, 1903, p. 77]) sandstones of Division E1b of Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River; (**344m** [*Matthew, 1903, p. 78*]) *sandy shales of Division E1d of Matthew's* [*1903, p. 21*] *Etcheminian, on Dugald Brook, Indian River;* and (**344n** [Matthew, 1903, p. 33]) shales in the gorge at the old mill on McCodrum Brook, Mira River; all in eastern Cape Breton, Nova Scotia.

Lingulella (Lingulepis) gregwa robusta (Matthew).

Lingulepis gregwa robusta Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 57. (Notes on orientation of shells.)

Lingulepis gregwa robusta Matthew, 1903, idem, p. 131. (Characterized as a new variety.)

Matthew separates a form with a thicker shell and straighter cardinal margins as the variety *robusta*. My impression is that these characters are so largely the result of the condition of preservation of the specimens in the matrix that the variety has very little value.

Formation and locality.—**Middle Cambrian:** (**10p**) Sandstone just below the waterfall in Division E2b of Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River; (**10p′**) sandstone one-fourth mile (0.4 km.) from lower bridge, on Gregwa Brook, Indian River; (**10p″**) sandstone on the small brook on the hill between the bridge over Indian River and McPhees Brook; (**13t″**) sandstones of Divisions E1c and E1d of Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River; (**344h** [Matthew, 1903, p. 79]) sandy layers in the shales of Division E1e of Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River; and (**344m** [*Matthew, 1903, p. 78*]) *sandy shales of Division E1d of Matthew's* [*1903, p. 21*] *Etcheminian, on Dugald Brook, Indian River;* all in eastern Cape Breton, Nova Scotia.

Lingulella (Lingulepis) longinervis (Matthew).

Plate XLIV, figures 2, 2a–g.

Lingulepis longinervis Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 133–135, Pl. VII, figs. 6a–g. (Described and discussed as a new species. The specimen represented by figure 6f is redrawn in this monograph, Pl. XLIV, fig. 2e.)

This species differs from *Lingulella* (*Lingulepis*) *gregwa* (Matthew) in having the sides of the ventral valve extended in a nearly straight line beyond the center of the valve. Some of Matthew's specimens have a concentrically striated surface with only a trace of the characteristic surface of *L.* (*L.*) *gregwa*. Others show more of the ornamented surface, and in specimens

[a] Doubtfully identified from this locality.

collected by S. Ward Loper from the same beds from which the types of *L.* (*L.*) *longinervis* came, the surface is indistinguishable from that of *L.* (*L.*) *gregwa*.

Matthew [1903, p. 134] considers the long, large "visceral callus" of the dorsal valve as the most prominent characteristic of this form. I find in *L.* (*L.*) *gregwa* (Matthew) and *L.* (*L.*) *exigua* (Matthew) that the visceral area in many specimens extends nearly to the front of the dorsal valve and that the length and strength of the visceral area in both ventral and dorsal valves of *Lingulepis* are not usually characters to be depended upon as criteria for specific determinations. The position assigned to the central and anterolateral muscle scars by Matthew [1903, Pl. VII, figs. 6e and 6f] appears to be theoretical, as a most careful study of the typical specimens fails to locate them as indicated in the figures. In fact, the specimens are too poorly preserved to indicate clearly where the scars are. Fine casts of the interior collected by Loper show the scars named farther toward the central portion of the shell.

Lingulella (*Lingulepis*) *longinervis* differs from *L.* (*L.*) *exigua* (Matthew) in its less attenuate ventral valve and less robust character in both size and thickness of shell.

The specimens collected by Matthew are small and do not show the variation that exists in the collection made by Loper. In a layer of reddish brown sandstone Loper found a great number of shells varying in size and form from those similar to Matthew's types to shells nearly twice as large. In a layer of hard gray standsone, 5 feet above, all the specimens are similar in size and form to those collected by Matthew. *Lingulella triparilis* (Matthew) occupies a position intermediate in form between *L.* (*L.*) *gregwa* (Matthew) and *L.* (*L.*) *longinervis*, and the surface characters of the three species are essentially of the same type.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**372f**) shales of unknown stratigraphic position; (**13d″**) sandstones 10 feet (3 m.) below Division E2a; (**13g**) sandstones 10 feet (3 m.) above Division E2a; (**13f**) sandstone 20 feet (6 m.) above Division E2a; (**13p** and **13p′**) sandstones 40 to 45 feet (12.2 to 13.6 m.) above Division E2a; (**13d**) sandstones opposite the third waterfall in Dugald Brook, between Divisions E2a and E2b; (**10p**) sandstones just below the waterfall, in Division E2b; (**344o** [*Matthew, 1903, p. 134*]) *sandstones of Division E2b;* and (**131**) shaly sandstones of Division E3a; all in Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

(**10p′**) Sandstone one-fourth mile (0.4 km.) from lower bridge, on Gregwa Brook, Indian River; and (**10p″**) sandstone on the small brook on the hill between the bridge over Indian River and McPhees Brook; both in eastern Cape Breton, Nova Scotia.

LINGULELLA (LINGULEPIS) PUMILA (Matthew.)

Plate XLV, figures 3, 3a.

Lingulepis pumila MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 75, Pl. VII, figs. 5a and 5b. (Described as a new species. The specimens represented by figs. 5a and 5b are redrawn in this monograph, Pl. XLV, figs. 3 and 3a, respectively.)

This species differs from *Lingulella triparilis* (Matthew) and *Lingulella* (*Lingulepis*) *gregwa* (Matthew) in having a more attenuate ventral valve. In this respect it resembles the narrow forms of *L.* (*L.*) *longinervis* (Matthew). The material is poor, so that only the general form can be used to characterize it. One dorsal valve shows that the shell was thick, very much as in *L.* (*L.*) *exigua* (Matthew). The surface of exfoliated shells is nearly smooth. Matthew [1903, p. 75] describes the outer surface as consisting of irregular concentric ridges, about six in the space of a millimeter.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**344f** [Matthew, 1903, p. 72]) Shales in the Coldbrook terrane of Matthew, on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

Specimens that are somewhat doubtfully referred to this species occur at the following locality:

Middle Cambrian: (**13k**) Shales of Matthew's [1903, p. 15] Coldbrook, above the great fall in Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

LINGULELLA (LINGULEPIS?) PYGMÆA (Salter).

Plate XXX, figure 10.

Lingula pygmæa SALTER, 1865, Quart. Jour. Geol. Soc. London, vol. 21, p. 102, figs. 8a and 8b, p. 101. (Described as a new species; see p. 557 for copy. Figs. 8a–b are copied in this monograph, Pl. XXX, fig. 10.)

Lingula pygmæa Salter, Davidson, 1866, British Fossil Brachiopoda, vol. 3, pt. 7, No. 1, p. 53, Pl. II, figs. 8 and 8a. (Text and figures copied from the preceding reference.)

Lingula pygmæa Salter, Phillips, 1871, Geology of Oxford and the Valley of the Thames, p. 68, Diagram XVII, fig. 13. (No text reference.)

Lingula pygmæa Salter, Matley, 1902, Quart. Jour. Geol. Soc. London, vol. 58, p. 141. (Synonymy given and species mentioned.)

The original description by Salter follows:

Minute, subcylindrical, gibbous; beak somewhat obtuse; auterior margin truncate; shell thin; surface finely striated transversely. Length, $\frac{1}{15}$ inch; width, $\frac{1}{20}$ inch. In the Black shales.

The Black shales are referred to the Upper Cambrian, the locality being in the eastern portion of the Malvern Hills of England. Davidson [1866, p. 53] states that he could only reproduce Salter's description and figure, as he had not seen specimens of the shell. The figure given by Salter [1865, figs. 8a and 8b, p. 101] is that of an elongate, cuneate shell more like the typical form of *Lingulepis* than *Lingulella*. From its form and the fact that it occurs in association with the *Olenus* fauna it is probable that it should be referred to *Lingulepis*.

Formation and locality.—**Upper Cambrian**: (**304f** [Salter, 1865, p. 102]) "Black shales" in the Malvern Hills, between Herefordshire and Worcestershire, England.

Lingulella (Lingulepis) roberti (Matthew).

Plate XXXVII, figures 4, 4a–d.

Lingulella roberti Matthew, 1895, Trans. Roy. Soc. Canada for 1895, 2d ser., vol. 1, sec. 4, No. 13, pp. 256–257, Pl. I, figs. 2a and 2b. (Described and discussed as a new species. Plate XXXVII, figs. 4, 4a–d of this monograph are drawn from specimens in Matthew's type material, and it is possible that the specimens represented by figs. 4a and 4b are the ones figured by Matthew, figs. 2a and 2b, respectively, but positive identification is impossible.)

Lingulepis roberti Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 132, Pl. VIII, figs. 5a–b. (Text and figures copied from the preceding reference.)

General form elongate ovate, with the ventral valve acuminate and the dorsal round ovate. The cardinal slopes of the ventral valve are in some shells slightly incurved as in *Lingulella* (*Lingulepis*) *acuminata* (Conrad); a portion of this curvature, as shown in Plate XXXVII, figures 4 and 4a, may be owing to the lateral compression of the shells. The convexity of the ventral valve is moderate, while that of the dorsal is unusually large (Pl. XXXVII, fig. 4b). This may be owing to the deformation of the shell by lateral pressure in the matrix.

Surface of the shell marked by very fine, obscure, radiating striæ and narrow undulations, and very fine, irregular, concentric striæ between relatively strong striæ and lines of growth. The irregular striæ inosculate, Plate XXXVII, figure 4c, so as to give an appearance much like that of *Obolus* (*Westonia*) *ella* (Hall and Whitfield) (Pl. XLVII, fig. 1o). When the thin outer layer is exfoliated, the dark shiny surface of the inner layers shows radiating striæ and concentric lines of growth. The inner surface appears to have been punctate to a moderate degree. The shell is moderately thick and is built up of a thin outer layer and several inner layers or lamellæ that anteriorly are slightly oblique to the outer layer, much as in *Lingulella acutangula* (Roemer).

The largest ventral valve among the type specimens has a length of 13 mm.; width, 9 mm.; the width is narrowed 2 or 3 mm. by the lateral compression. A dorsal valve that is very little, if any, distorted is 10 mm. long and 10 mm. wide. A trace of the pedicle groove in the ventral valve is shown by Plate XXXVII, figure 4a. The area of the dorsal valve is not preserved in any of the specimens sent to me by Matthew.

The cast of the visceral cavity is shown in Plate XXXVII, the ventral valve in figure 4a and the dorsal valve in figure 4b.

The anterior lateral and central muscle scars are seen in the specimens of the type sent me by Matthew. In g and h, figure 4b, of Matthew's figures, the umbonal scar is short and broad, as in *Obolus selwyni* (Matthew) (Pl. XXXVII, fig. 1f).

The markings of the vascular system observed are the main vascular sinuses of the ventral valve, a trace of them in the dorsal valve, and a little of the parietal scar about the visceral cavity in the dorsal valve (fig. 4b).

Observations.—This species is related by its form to *Lingulella* (*Lingulepis*) *gregwa* (Matthew) and *L.* (*L.*) *longinervis* (Matthew), but it differs in its surface characters. In its very fine, irregular striæ and general form it is closely allied to *L.* (*L.*) *exigua* (Matthew). The thick, robust shell and numerous strong pits on the inner surface of the shell give the latter a character not seen in *L.* (*L.*) *roberti*.

The visceral area and muscular scars of the ventral and dorsal valves are much like those of *Obolus selwyni* (Matthew) (Pl. XXXVII), and in specimens of the same size occupy relatively the same position. The specific variations between the two species appear to be in the shape of the valves and the character of the finer ornamentation of the surface.

Matthew originally [1895, p. 257] referred this species to the Ordovician fauna, but in his review of the Cambrian fauna of Cape Breton [1903, p. 132] it is referred to his lower Etcheminian.

The specific name was given in honor of Mr. J. Alfred Robert, of the Geological Survey of Canada, who collected the specimens of the species.

Formation and locality.—**Middle Cambrian:** (**307d** [Matthew, 1903, p. 132]) Sandy limestone of Division E2a? of Matthew's Etcheminian, on Young (McFees) Point [Matthew, 1903, p. 19], near George River station, Cape Breton, Nova Scotia.

Lingulella (Lingulepis) rowei (Walcott).

Plate XXI, figures 4, 4a–b.

Obolus (*Lingulepis*) *rowei* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 334. (Characterized as a new species.)

This shell differs from *Lingulella* (*Lingulepis*) *acuminata* (Conrad) and other species of *Lingulella* and *Lingulella* (*Lingulepis*) in the sharp, fine, concentric ridges of the outer surface, about six to the millimeter. This surface resembles closely that of *Obolus* (*Palæobolus*) *bretonensis* Matthew. The material is not well preserved, but there is sufficient to illustrate the form of the valves and the character of the surface. A fragment shows a more attenuate posterior portion of a ventral valve than the one illustrated.

The specific name is given in memory of Mr. R. B. Rowe, assistant geologist of the United States Geological Survey, who collected the material a short time before his death.

Formation and locality.—**Lower Cambrian:** (**14p**) Reddish-brown quartzitic sandstone, near Resting (Freshwater) Springs, which is in the southwest corner of T. 21 N., R. 8 E., on Amargosa River, in the southeastern part of Inyo County, California.

Lingulella (Lingulepis) spatula (Walcott).

Plate XIX, figures 5, 5a–b.

Obolus (*Lingulella*) *spatulus* Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 607. (Described and discussed as below as a new species.)

General form of the ventral valve spatulate, the sides sloping from the apex forward with a very slight curvature to the anterior fifth of the shell, where they pass into the broadly rounded frontal margin.

Dorsal valve ovate with the greatest width toward the front. Convexity moderate, and about equal in both valves. A ventral valve 9 mm. in length has a convexity of about 1 mm. A fragment of the outer surface indicates that the surface was relatively smooth, being broken only by fine, scattered striæ of growth. The inner layers show concentric lines, also fine, radiating striæ. The interior of the shell was marked by scattered pustules, concentric striæ, and a few radiating lines.

The largest ventral valve has a length of 9 mm. and a width of 6 mm. A dorsal valve 5 mm. in width has a length of 7 mm.

The only trace of the vascular system preserved is the median ridge of the dorsal valve, which extends forward to the anterior fourth of the shell.

Observations.—This very pretty little shell occurs in abundance in the chocolate brown sandstone interbedded in the shales, just above the massive "Tonto" sandstone. It is distinct

from all other species known to me from the Cambrian rocks of the Grand Canyon region. *Obolus (Westonia) chuarensis* (Walcott) occurs in a layer of sandstone 50 or 60 feet higher up in the section.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**74d**) Sandstone beds in "Tonto" shale just above massive sandstones near mouth of Bass Canyon, on the south side of the Grand Canyon of the Colorado, southeast of Powells Plateau, Arizona.

LINGULELLA (LINGULEPIS?) SQUAMOSA (Holl).

Plate XXX, figure 9.

Lingula squamosa HOLL, 1865, Quart. Jour. Geol. Soc. London, vol. 31, pt. 1, p. 102. (Described as a new species; see below for copy.)

? Lingula squamosa Holl, DAVIDSON, 1866, British Fossil Brachiopoda, vol. 3, pt. 7, No. 1, p. 41, Pl. II, fig. 7. (Copies the original description and discusses species. Fig. 7 is copied in this monograph, Pl. XXX, fig. 9.)

The original description by Holl follows:

Triangular, broad anteriorly, compressed; beak acute; anterior margin truncate; shell thick, strongly grooved from side to side by imbricating lines of growth. Length, one-fourth inch. In the light-brown felspathic sandstone of the Hollybush series.

The sandstone of the Hollybush series is beneath the Black shales in which *Lingulella (Lingulepis?) pygmæa* (Salter) occurs, but appears to form a portion of the Upper Cambrian of the Malvern Hills section. The species has a peculiar cuneate form, more like that of *L. (L.) acuminata* (Conrad) than any other European shell known to me. On this account it is referred to the subgenus *Lingulepis*.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**304g** [Holl, 1865, p. 102]) Sandstones of the Hollybush series, Malvern Hills, between Herefordshire and Worcestershire, England.

LINGULELLA (LINGULEPIS) STARRI (Matthew).

Plate XXXVII, figures 2, 2a–b.

Lingulella starri MATTHEW, 1891, Trans. Roy. Soc. Canada for 1890, 1st ser. vol. 8, sec. 4, No. 6, pp. 146–147, Pl. XV, figs. 5a–c, 6a–b. (Described and discussed as a new species. According to Matthew the type specimens have been mislaid or lost, and the specimens represented in this monograph are from new material collected by him.)

Lingulepis starri MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 195. (Mentioned.)

General form cuneate, elongate ovate, with the ventral valve obtusely acuminate and the dorsal valve broadly ovate; valves appear to have been moderately convex. Outer surface of the shell marked by fine, concentric, slightly irregular striæ, 8 to 12 in the space of a millimeter; when the outer layer of shell is exfoliated coarser concentric striæ are seen; and on the inner surface of the shell strong concentric striæ and numerous radiating striæ occur, the latter being most prominent on the anterior half of the valves. The shell is strong and is built up of a thin outer layer and several inner layers or lamellæ, very much as in *Lingulella acutangula* (Roemer).

A large ventral valve, as measured by Matthew, has a length of 16 mm.; width, 14 mm.

A cast of the interior of a broken ventral valve shows the visceral cavity (v) and a trace of the main vascular sinus (Pl. XXXVII, fig. 2b).

Observations.—This is one of the large species of the genus and compares in this respect with *Lingulella ampla* (Owen) and *Obolus (Westonia) aurora* (Hall). Matthew wrote me that the type of this species had been mislaid or lost. The illustrations are taken from other specimens identified and labeled by him.

The specific name was given in honor of Mr. R. P. Starr, who discovered the species.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**308c** [*Matthew, 1891, p. 147*]) *Shales of Division 2b of Matthew's Johannian at St. John;* and (**2x**) thin-bedded sandstones of Division 2 of Matthew [1892, p. 59], on the south shore of Long Island, Kennebecasis Bay [Matthew, 1898a, pp. 124 and 127]; both in St. John County, New Brunswick.

Lingulella (Lingulepis?) sp. undt. (Walcott).

Obolus (*Lingulepis*) sp. undt. Walcott, 1906, Proc. U. S. Nat. Mus., vol. 30, pp. 567–568. (Characterized as below as an undetermined species.)

This species is represented by a few fragments, one of which shows that the ventral valve is elongate, and the apex acuminate. The shell was built up of several layers or lamellæ, as in characteristic forms of *Lingulella* (*Lingulepis*). The interior surface of some of the lamellæ is marked by fine, radiating, and concentric striæ; the outer surface, under a strong magnifier, shows fine, concentric, somewhat irregular striæ.

Formation and locality.—**Middle Cambrian**: (C72) Thin green-gray limestone interbedded with ocherous and green clay shales, overlying the massive oolite in the Kichou formation [Willis and Blackwelder, 1907, pp. 139 and 145 (3d list of fossils)], 4 miles (6.4 km.) east of Fanglanchon, Shansi, China.

Genus DELGADELLA Walcott.[a]

Delgadella Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 144. (Classification of genus.)

The description of the type species includes all that is known of this genus. The form of the shell is more like that of Lower Ordovician species referred to *Lingula* than to the typical forms of *Lingulella* or *Lingulepis*.

Type.—*Lingulepis lusitanica* Delgado.

The generic name is given in memory of the late Mr. J. F. Nery Delgado, of the Geological Survey of Portugal.

Delgadella lusitanica (Delgado).

Plate XXIX, figures 5, 5a–b.

Lingulepis lusitanica Delgado, 1904, Communicações Commissão Serviço Geologico Portngal, tome 5, fasc. 2, pp. 365–366, Pl. IV, figs. 31–34. (Characterized and discussed in French as a new species. Photographs of the specimens represented by figs. 31, 32, and 34 are reproduced in this monograph, Pl. XXIX, figs. 5a, 5b, and 5, respectively, each individual figure being a reversed view of Delgado's original figure.)

General form elongate ovate, moderately convex. The greatest width of the ventral valve is at the anterior third, whence the outline narrows slightly to the broadly rounded front, and gradually to the subacuminate posterior half.

Dorsal valve unknown, unless Plate IV, figure 17, and possibly figure 27, of Delgado, represents it. However, these two shells are referred in this monograph to *Lingulella delgadoi* (p. 491) as they appear to be more closely related to that species than to *Delgadella lusitanica*.

Shell thick and with a thick margin. This is shown by the casts of the edges of the valves, as shown by figures 5 and 5a. Shell substance unknown. Delgado [1904, p. 365] states that the shells range from 5 to 8.5 mm. in length.

Observations.—Delgado referred this species to *Lingulepis* on account of its general form, but from the fact that it has a thick, strong shell and does not have the attenuated extension of the apex of the ventral valve of the typical forms of *Lingulepis* I am inclined to refer it to a new genus characterized by a thick shell, spatulate form, with a subacuminate beak. A shell agreeing with this in outline and form occurs in the Lower Ordovician shales at Kelleys Island, Conception Bay, Newfoundland.

Delgado [1904, p. 365] compares this species with the very young shells of *Lingula lesueuri* Rouault [Davidson, 1866, Pl. I, figs. 1–11]. If the specimens representing it had been sent to me without any information as to the associated fauna, I should have been strongly inclined to refer them to a Lower Ordovician fauna.

Lingulella (*Lingulepis*) *acuminata meeki* (Walcott) has a somewhat similar outline, but that is a thin, corneous shell of the Upper Cambrian fauna. We must await further discoveries of more perfectly preserved material before a more complete description can be given.

[a] Prior to the definition of the genus *Delgadella* the type species was described under *Lingulepis* [Delgado, 1904, p. 365].

Mr. Delgado very kindly sent me a specimen of this species, also some large photographs of specimens illustrated by him. I have reproduced three of these in illustration of the species.

FORMATION AND LOCALITY.—**Lower Cambrian:** (**351** [Delgado, 1904, p. 365]) Shales at Monte de Valbom, northeast of Villa Boim, Province of Alemtejo, Portugal.

Subfamily ELKANIINÆ Walcott and Schuchert.

Genus ELKANIA Ford.[a]

Billingsia FORD [not DE KONINCK, 1876], 1886, Am. Jour. Sci., 3d ser., vol. 31, pp. 466–467. (Described and discussed as a new genus.)

Not *Billingsia* WALCOTT, 1886, Bull. U. S. Geol. Survey No. 30, pp. 5, 21, 60, and 62. (Used in lists for a genus of the Gastropoda.)

Elkania FORD, 1886, Am. Jour. Sci., 3d ser., vol. 32, p. 325. (Proposes *Elkania* for *Billingsia*, which was preoccupied.)

Elkania Ford, HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 241. (Described.)

Elkania Ford, HALL and CLARKE, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, p. 557. (Copy of preceding reference.)

Elkania Ford, HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 75–78. (Copies part of Billings's, 1861b, p. 70, description of "*Obolella desiderata*" and Ford's, 1886a, p. 467, description of the genus, and describes and discusses genus.)

Elkania Ford, WALCOTT (in part), 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 321–323. (Described and discussed essentially as below. The text includes reference to species now placed under *Obolus* (*Fordinia*).)

Elkania Ford, WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 144. (Classification of genus.)

General form ovate, biconvex; shell substance corneous and made up of several thin layers or lamellæ that increase in number toward the front and lateral margins. Surface marked by fine concentric striæ of growth. Apex of both ventral and dorsal valves marginal. The interior of the ventral valve has a thickened posterior section which has a central pedicle furrow and two flexure lines running obliquely forward and outward from the apex, a little inside of the grooves of the main vascular trunks; this structure is apparently the result of the union of the area with the bottom of the shell so as to bring, as the shell grew, the path of advance of the pedicle groove, main vascular sinuses, and lateral muscle scars all on one surface instead of on the area and the shell beneath it as in *Obolus*.

The muscle scars are arranged as in *Obolus*. The transmedian and anterior laterals occur well out toward the margin (Pl. LI, fig. 1) and the space inclosing the central, middle lateral, and outside lateral scars is in the central area, on the front of the slope of the thickened posterior portion of the valve (Pl. LI, figs. 1 and 3a); the points of attachment of the individual muscles can not be distinguished. In the dorsal valve the central and anterior lateral scars are clearly shown in several specimens; the transmedian and outside laterals are situated just outside the main vascular sinus (Pl. LI, fig. 1c). Our knowledge of the vascular markings is limited to the main vascular sinuses, except in one ventral valve, where the inner branches have been preserved; in both valves the main trunk rises near the apex and its path is outlined across the internal cardinal area.

The preceding description differs materially from that of Ford [1886a, p. 467] and Hall and Clarke [1892c, p. 77]. I find the muscle scars as described above and am compelled to consider them as indicating the same muscles as in *Obolus*. That the genus is an advance on *Obolus* in the evolution of the inarticulate brachiopods I quite agree with Hall and Clarke [1892c, p. 165], but not that it is a stage in the transition from *Obolus* to *Trimerella* and its allies. (See remarks on platform, p. 309.) *Elkania* is an *Obolus* with the cardinal areas within the plane of the margins of the valves. In the type species, *Elkania desiderata* (Billings), the area of the ventral valve is entirely within the valve, while that of the dorsal valve has been nearly obliterated in the process of change from an open backward-facing area to an inclosed forward-facing

[a] The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Elkania* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Obolella Billings [1862d, pp. 69 and 71].
Obalella Davidson [1868, p. 309].
Obolella? Walcott [1884h, p. 67; 1886b, p. 111].

area. A comparison of the interiors of *Obolus apollinis* Eichwald (Pl. VII, figs. 1–17) with those of *Obolus* (*Fordinia*) *bellulus* (Walcott) (Pl. LI, figs. 3a–f) and *Elkania desiderata* (Billings) (Pl. LI, figs. 1, 1a–d) illustrates how little change is necessary to convert the exterior cardinal areas of *Obolus* into the inclosed internal areas of *Elkania*.

As the beaks of *Elkania* are marginal, the pedicle passed out through an opening made by the gaping of the valves.

The three known species of the genus are the type species *Elkania desiderata* (Billings), *E. ambigua* (Walcott), in which the shell is very thick, and *E. ida* (Billings).

Authors have referred frequently to the resemblance between species of *Obolella* and *Elkania desiderata*. This does not appear to exist except in a superficial manner. *Obolella* is a stage in the evolution toward the Siphonotretidæ, whereas *Elkania* has no known descendants.

The generic name was given in honor of Dr. Elkanah Billings, of the Geological Survey of Canada.

Elkania ambigua (Walcott).

Plate LI, figures 2, 2a–c.

Obolella? ambigua Walcott, 1884, Mon. U. S. Geol. Survey, vol. 8, pp. 67–68, Pl. I, figs. 2a–c. (Described and discussed as a new species. The specimens represented by figs. 2a–c are redrawn in this monograph, Pl. LI, figs. 2a, 2, and 2b, respectively.)

Billingsia? ambigua (Walcott), Ford, 1886, Am. Jour. Sci., 3d ser., vol. 31, p. 467. (Generic relations mentioned.)

Elkania ambigua (Walcott), Ford, 1886, idem, vol. 32, p. 325. (Merely changes generic reference.)

Elkania ambigua (Walcott), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 78. (Generic relations discussed.)

General form ovate; biconvex; beaks marginal. Surface marked by fine concentric striæ of growth. Substance of shell corneous as far as can be determined, although some of the layers appear to be calcareous. The shell is made up of many thin layers or lamellæ.

Ventral valve elongate oval, moderately convex. Dorsal valve transversely broad ovate; the interior shows a slender median septum at the bottom of a shallow, concave, well-defined visceral area; within the latter area the central muscle scars occur at the outer margins about one-half the distance from the posterior margin to the anterior margin of the visceral area; the anterior lateral scars are close together on each side of the median septum at the anterior margin of the area; the thickening of the shell varies greatly in different shells; in some it extends far to the front (Pl. LI, fig. 2c) and in others it is scarcely noticeable (fig. 2b).

No interiors of the ventral valve have been found and the cardinal area of the dorsal valve is unknown. The largest dorsal valve has a length of 9 mm.; width, 10 mm.

This species in size and form is related to *E. desiderata* (Billings); it differs in the character of the interior of the dorsal valve, and in having a thicker and stronger shell in the adult stage.

When the species was first described its relations were uncertain, hence the specific name.

Formation and locality.—**Lower Ordovician:** (63) *Base of the Pogonip limestone, northeast of Adams Hill;* and (202) Pogonip limestone, on the summit of the ridge directly southeast of the Jackson mine, northwest of Shadow Canyon; both in the Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

Elkania desiderata (Billings).

Plate LI, figures 1, 1a–d.

Obolella desiderata Billings, 1862, Geol. Survey Canada, Paleozoic Fossils, vol. 1, pp. 69–70, figs. 62a–b. (Described and discussed as a new species. The specimens represented by figs. 62a and 62b are redrawn by Hall and Clarke, 1892c, Pl. III, figs. 16 and 17, respectively.)

Obolella desiderata Billings, Davidson, 1868, Geol. Mag., vol. 5, figs. 1 and 2, p. 309. (Mentioned.)

Obolella? desiderata Billings, Walcott, 1886, Bull. U. S. Geol. Survey No. 30, p. 111. (Generic relations discussed.)

Billingsia desiderata (Billings), Ford, 1886, Am. Jour. Sci., 3d ser., vol. 31, pp. 466 and 467, fig. 1, p. 466. (Generic relations discussed.)

Elkania desiderata (Billings), Ford, 1886, idem, vol. 32, p. 325. (Merely changes generic reference.)

Elkania desiderata (Billings), Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, Pl. III, figs. 13 and 14. (No text reference. Figs. 13 and 14 are drawn from casts of the two specimens figured by Billings, 1862d, figs. 62a and 62b, p. 68, the specimens themselves being redrawn in Hall and Clarke, 1892c, Pl. III, figs. 16 and 17, respectively.)

Elkania desiderata (Billings), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 76 and 77, Pl. III, figs. 15–19. (Part of original description, Billings, 1862d, p. 70, copied on p. 76 and species described and discussed. Figs. 16 and 17 are drawn from the specimens figured by Billings, 1862d, figs. 62a and 62b, p. 68; figs. 15 and 18, which represent casts of the specimens represented by figs. 16 and 17, respectively, are copied from figs. 13 and 14 of the preceding reference.)

The species has been so thoroughly described by Billings [1862d, p. 69], Ford [1886a, p. 466], and Hall and Clarke [1892c, p. 77], from their respective points of view, that I will confine my observations to the interior characters. As noted under the genus, I regard the cardinal areas as being reversed; that is, sloping within the plane of the margins of the valves instead of without, as in *Obolus;* the space beneath the area and the bottom of the valve is filled with shell, and the margin of the area thus disappears in the anterior slope of the thickened portion of the shell.

The scheme of muscle scars, as far as they are known, is the same as in *Obolus*. In the ventral valve the anterior laterals (j) and transmedians (i) occur outside the main vascular sinuses toward the margin of the valve and in front of the included cardinal area. The space occupied by the central and middle and outside lateral scars is defined on the front slope of the umbonal thickening of the valve. The muscle scars of the dorsal valve include the transmedian and outside laterals on the outer margin of the main vascular sinuses, and the central and anterior laterals on the margins of the central visceral area.

The vascular markings include the main vascular sinuses in the two valves, and some inner branches in the ventral valve.

Elkania desiderata differs from *E. ambigua* (Walcott), the only related species, in the interior of the dorsal valves, which are the only parts we have for comparison. The shell is also thinner.

Formation and locality.—**Lower Ordovician:** (**319a**) Levis shales, Point Levis, Province of Quebec, Canada.

Elkania ida (Billings).

Plate XXX, figures 20, 20a; Plate LI, figures 4, 4a–c.

Obolella ida Billings, 1862, Geol. Survey Canada, Paleozoic Fossils, vol. 1, p. 71, fig. 63a–b. (Described and discussed as a new species, see below for copy.)
Obolella? ida Billings, Walcott, 1886, Bull. U. S. Geol. Survey No. 30, p. 111. (Generic relations mentioned.)
Billingsia? ida (Billings), Ford, 1886, Am. Jour. Sci., 3d ser., vol. 31, p. 467. (Generic relations mentioned.)
Elkania ida (Billings), Ford, 1886, idem, vol. 32, p. 325. (Merely changes generic reference.)

The original description by Billings follows:

Shell small, obtusely ovate, greatest width at or a little in front of the middle, abruptly narrowed to the beaks, sides and front margin uniformly rounded, the front slightly less convex than the sides. Both valves equally and rather strongly convex, most elevated at about one-third the length from the apex, thence sloping with a gentle curve to the sides and front margin, abruptly descending on each side of the beak and umbones. Ventral valve slightly more pointed above than the dorsal; umbo narrowly convex; beak apparently depressed to the level of the lateral margin. Dorsal valve obtusely angular or narrowly rounded at the beak, the latter not visibly distinct from the cardinal edge; umbo obtusely convex. Surface with a somewhat shining aspect, with very fine concentric striæ; a few radiating striæ are visible on two of the specimens. Shell apparently very thin.

Length of a perfect ventral valve, 2 lines; width, 1⅞ lines. The length and width of the dorsal valve are about equal.

In some material from the McGill University Museum, kindly lent to me by Sir William Dawson and Dr. Frank D. Adams, I found some fine specimens labeled *Obolella ida*, collected by J. Richardson. These specimens show the characters described by Billings [1862d, p. 71] and in addition the following: The shell is corneous and built up of many lamellæ or layers arranged obliquely to the surface so as to form a thick, strong shell. The interior of the ventral valve has a thickened umbonal portion with a pedicle groove much like that in *E. desiderata* (Billings), but much shorter in proportion; owing to the imperfect condition of the remaining portions, no further details can be determined. The interior of the dorsal valve shows a thickened elevated area like that of the dorsal valve of *E. desiderata* (Pl. LI, fig. 1d), but differently shaped. A large transverse depression just in advance of the posterior margin appears

to be all that is left to indicate the cardinal area; the central muscle scars are situated just in advance of this depression and the anterior laterals at the front end of the visceral area; the position of the transmedian and outside lateral scars is indicated by an elongate scar near the posterolateral margin, just in advance of the traces of the cardinal area. Vascular markings unknown.

This species differs from *E. desiderata* in having a thicker and more convex shell and has a differently shaped visceral area in the dorsal valve.

FORMATION AND LOCALITY.—**Lower Ordovician:** (319)[a] Limestone No. 1 of Billings's section; and (319i) limestone of Billings's section; both at Point Levis, Province of Quebec, Canada.

Subfamily NEOBOLINÆ Walcott and Schuchert.

Genus NEOBOLUS Waagen.

[νέος, young; and Obolus.

Neobolus WAAGEN, 1885, Mem. Geol. Survey India, Paleontologia Indica, 13th ser., Salt Range Fossils, vol. 1, pt. 4, fas. 5, pp. 756–758. (Described and discussed as a new genus.)

Davidsonella WAAGEN [not MUNIER-CHALMAS, 1880], 1885, idem, pp. 762–764. (Described and discussed as a new genus.)

Neobolus Waagen, OEHLERT, 1887, Manuel de conchyliologie, by Fischer, p. 1263. (Described in French, with figures of *Neobolus warthi*.)

Lakhmina OEHLERT, 1887, idem, p. 1265. (Described in French, with figures of "*Lakhmina linguloides*.")

Lakhmina Oehlert, WAAGEN, 1891, Mem. Geol. Survey India, Paleontologia Indica, 13th ser., Salt Range Fossils, vol. 4, pt. 2, description of Pl. II, figs. 3–4. (No text reference.)

Lakhmina Oehlert, HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, pp. 234–235. (Described.)

Neobolus Waagen, HALL and CLARKE, 1892, idem, p. 245. (Described.)

Lakhmina Oehlert, HALL and CLARKE, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, pp. 550–551. (Copy of Hall and Clarke, 1892a, pp. 234–235.)

Neobolus Waagen, HALL and CLARKE, 1892, idem, p. 561. (Copy of Hall and Clarke, 1892a, p. 245.)

Lakhmina Oehlert, HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 28–30. (Described and discussed.)

Neobolus Waagen, HALL and CLARKE, 1892, idem, p. 84. (Described and discussed.)

Neobolus Waagen, WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 72–76. (Described and discussed as below, with the exception of the paragraph describing the two text figures.)

Neobolus Waagen, WALCOTT, 1908, idem, vol. 53, No. 4, Pl. XI, and pp. 142 and 144. (Classification of genus.)

General outline of shells broad oval to subcircular; nearly equivalve, moderately convex. Shell substance calcareocorneous and probably phosphatic, structure laminated. Surface with concentric striation. Shell strong for its size and built up on its anterior and lateral margins of several thin layers or lamellæ. Apex of ventral valve small and slightly projecting over a low false area that appears to have an open delthyrium. Apex of dorsal valve marginal.

The interior of the ventral valve has a strong, rounded, central ridge extending from the narrow area, about one-third the length of the shell, and a strong ridge on each side that extends from the same point of origin as the central ridge obliquely forward nearly to the frontal margin of the shell;[b] between the central ridge and the posterior portions of the lateral ridges there are slightly concave shelves forming, with the central ridge, a triangular platform, with an open space beneath the concave shelves; numerous radiating striæ occur on the concave shelves and the inner surface of the shell.

Of the muscular impressions in the ventral valve, Waagen wrote [1885, p. 762] that "nothing can be observed." Considered from the point of view of the Trimerellidæ, this may appear to be correct, but if we compare the muscle scars of *Obolus* with what appear to me to be points of attachment of muscles in the specimen represented by Plate LXXXI, figure 2e, there is no difficulty in recognizing a few scars. Just beneath the outer extension of the narrow area of the ventral valve there is a minute, clearly defined, elongate, oval space that corresponds to the divided umbonal muscle scar in *Obolus apollinis* Eichwald; near the outer

[a] This is the locality from which the species is listed in the collections of the Geological Survey of Canada. Billings [1862b, p. 71] also identifies the species from No. 2 of his section.

[b] I do not find any indication of the incurving of these ridges as described and illustrated by Waagen [1885, p. 762, Pl. LXXXV, fig. 6].

margin, on a line with the anterior portion of the central ridge, there is a narrow elongate space which, under a strong reflected light, is seen to be divided diagonally by a slight, narrow, raised line. Compared with *Obolus* this space is the point of attachment of the transmedian and anterior lateral muscle scars. It is probable that the outside and middle lateral muscle scars and the centrals were attached to the platform, but there are no defined muscle scars upon it.

The interior of the dorsal valve has several very unusual characters. There is no true cardinal area, unless the thick margin of the shell be considered as such; from the center of the cardinal margin a strong flat process marked by concentric lines of growth projects forward into the valve and rises a little above the plane of the margin of the valve. Waagen [1885, p. 763] calls attention to the resemblance between this process and the tooth of *Trimerella lindströmi*. From beneath the median process a short, thick platform projects upward and forward into the valve (Pl. LXXXI, figs. 2f, 2g, and 2h); it is as wide as the process at its base, expanding toward its front margin. It is concave between its lateral crests, and the outer slopes are slightly concave from the crest to the body of the shell; in front the concave space and crests terminate rather abruptly above the front face, which in turn is underlain by a transversely hollow space of unknown extension beneath the platform. Toward each end of the frontal area a minute depression appears to indicate the point of attachment of a muscle. A narrow, rounded median septum extends from beneath the platform well toward the front of the shell. Two more or less interrupted and obscure ridges, indicating the main vascular trunks, extend from the front anterolateral angles at the base of and at the side of the platform obliquely outward into the valve. The elongate smooth spaces outlined by Waagen [1885, Pl. LXXXV, fig. 6] in his illustrations of this valve are too indefinite to be given form in the drawing of the only specimen showing the interior. What appears to be a small muscle scar occurs at the cardinal angle; it corresponds in position to the transmedian scar of *Obolus*.

Figure 47A, page 567, shows the area, median ridge, and side ridges of the visceral area of the dorsal valve. The platform shown by Plate LXXXI, figure 2f, has not been developed beyond the first stages of its growth. It is probable that the fully developed platform occurs only in very old shells. There is no trace of a platform in the specimen represented by Plate I, figure 3, but it may have been broken away. In another shell, not illustrated, there is no trace of thickening beneath the visceral area. In a section of the platform, median ridge, and vascular sinuses taken where they unite with the inner surface of the dorsal valve (fig. 47B, p. 567) the platform appears to be intermediate in development between the platforms represented by figure 47A, page 567, and Plate LXXXI, figure 2f.

Type.—Neobolus warthi Waagen.

Observations.—Through the courtesy of Dr. T. H. Holland, director of the Geological Survey of India, I received the type specimens of *Neobolus, Davidsonella,* and *Lakhmina,* studied, described, and illustrated by Waagen. With these before me I find that the elaborate figures of Waagen [1885, Pl. LXXXV] are diagrammatic to a considerable extent, also that I can not clearly recognize some of the characters noted by Waagen.

Waagen's original description [1885, p. 762] of the genus "*Davidsonella*" is very full and he also gives a detailed description of the type species "*D. linguloides.*" Oehlert [1887, p. 1265] evidently based his description of "*Lakhmina*" on Waagen's description and illustrations, apparently not noting that Waagen stated in his text [1885, p. 762] that the elongate area on the sides of the interior of the shell were not muscle scars, but that he considered them as smooth areas outside the crescent.

Oehlert [1887, p. 1265], when describing the genus *Lakhmina,* says, "with a straight and projecting beak perforated for the passage of the foramen." He reproduces Waagen's figures and shows a deep pedicle furrow. This leads me to think that he had Waagen's description and figures in mind when writing his diagnosis of *Lakhmina.* Only one shell shows the apex of the ventral valve and the small false area beneath, and one other of the interior shows the true area and a triangular depressed spot at the center; a fracture at the center has broken

out a bit of the shell which gives rise to the narrow, deep furrow described by Waagen. The ventral valve has (a) a false area beneath the apex, and (b) a true area on a plane with the margins of the valve.

When looking over the types of *Neobolus* and *Lakhmina* for the purpose of having illustrations made of them, I noted that there was a strong resemblance between the sheils of the two genera, but having the impression that the ventral valve of *Lakhmina* had a pedicle opening at the apex, drawings were arranged on the plates under the conception that *Lakhmina* belonged with the Neotremata. Schuchert noted the same resemblance when looking over the plates of this monograph and called my attention to it. I then made a careful study of all of the specimens and by the use of acid developed several interiors of dorsal valves. I found that the supposed perforation of the apex of the ventral valve of *Lakhmina* was the result of the breaking out of the minute apex; that the dorsal valve of *Neobolus warthi* was the same as the dorsal valve of *Lakhmina linguloides* and that two genera and four species had been based on specimens of *Neobolus warthi.*

The external characters of all of the shells referred to *Neobolus* and *Lakhmina* are the same. Only one specimen of the interior of the ventral valve that shows anything of the platform beneath the visceral area occurs in the collections; this was referred to *Lakhmina* by Waagen, but the accompanying dorsal valves were first described as *Neobolus.* By comparing the illustrations of Waagen [1891, Pl. II] the student will notice that figure 8c of the interior of the dorsal valve of *Neobolus* is essentially the same as the interior of the dorsal valve of *Lakhmina* (fig. 4c) with the exception of the thickened platform.

It may seem as though it were forcing unlike forms into one species to place the specimen represented by Plate LXXXI, figures 2f, 2g, and 2h, with those represented by figures 47A and 47B, page 567, but with our present information it appears to be necessary to do so.

All authors have classified the shells described as *Lakhmina linguloides* with *Trimerella,* and Hall and Clarke [1892c, p. 29] state that in the present condition of knowledge it must be regarded as the earliest representative of the trimerelloid Brachiopoda. The external form is similar to that of *Obolus* and the interior characters might readily have been developed from that genus, but the platform is posterior and not central as in the trimerelloids.

Neobolus warthi Waagen.

Text figures 47A–B, page 567; Plate I, figures 3, 4, 4a–b, 5, 5a; Plate LXXXI, figures 2, 2a–h.

Neobolus warthi Waagen, 1885, Mem. Geol. Survey India, Paleontologia Indica, 13th ser., Salt Range Fossils, vol. 1, pt. 4, fas. 5, pp. 758–759, Pl. LXXXIV, figs. 3–8. (Described and discussed as a new species. The three specimens represented by figs. 4, 5a–b, and 7 are redrawn in this monograph, Pl. I, figs. 4, 4a, and 3, respectively.)

Neobolus wynnei Waagen, 1885, idem, pp. 759–761, Pl. LXXXV, figs. 1 and 2. (Described and discussed as a new species. The two specimens represented by figs. 1a–c and 2a–c are redrawn in this monograph, Pl. I, figs. 5 and 5a, respectively.)

Davidsonella linguloides Waagen, 1885, idem, pp. 764–766, Pl. LXXXV, figs. 3–6. (Described and discussed as a new species. The four specimens represented by figs. 3a–b, 4a–b, 6, and 5 are redrawn in this monograph, Pl. LXXXI, figs. 2, 2d, 2e, and 2f–h, respectively.)

Davidsonella squama Waagen, 1885, idem, pp. 766–767, Pl. LXXXVI, fig. 1. (Described and discussed as a new species. In 1891 [Pl. II, figs. 6a–b] Waagen figures the specimen represented by figs. 1a–b as *Neobolus warthi.* The specimen represented by figs. 1a–b is redrawn in this monograph, Pl. LXXXI, fig. 2a.)

Neobolus warthi Waagen, Oehlert, 1887, Manuel de conchyliologie, by Fischer, p. 1263, fig. 1012. (No text reference. The two figures are copied from Waagen, 1885, Pl. LXXXIV, figs. 6 and 7.)

Lakhmina linguloides (Waagen), Oehlert, 1887, idem, p. 1265, fig. 1015. (No text reference. The two figures are copied from Waagen, 1885, Pl. LXXXV, figs. 5 and 6.)

Lakhmina linguloides Waagen, 1891, Mem. Geol. Survey India, Paleontologia Indica, 13th ser., Salt Range Fossils, vol. 4, pt. 2, Pl. II, figs. 3a–c and 4a–c. (No text reference. Figs. 3a–b and 4a–b are copied from Waagen, 1885, Pl. LXXXV, figs. 3a–b and 4a–b, respectively; figs. 3c and 4c are copied from Waagen, 1885, Pl. LXXXV, figs. 6 and 5, respectively.)

Neobolus warthi Waagen, 1891, idem, Pl. II, figs. 5–9. (No text reference. Figs. 5, 6a–b, 8a–b, and 8c are copied from Waagen, 1885, Pl. LXXXIV, fig. 4; Pl. LXXXVI, figs. 1a–b; Pl. LXXXIV, figs. 5a–b; and Pl. LXXXIV, fig. 7; respectively. The specimen figured by Waagen, 1885, Pl. LXXXVI, figs. 1a–b, as *Davidsonella squama* is figured by him later, 1891, Pl. II, figs. 6a–b, as *Neobolus warthi.*)

Neobolus wynnei WAAGEN, 1891, Mem. Geol. Survey India, Paleontologia Indica, 13th ser., Salt Range Fossils, vol. 4, pt. 2, Pl. 11, figs. 10 and 11. (No text reference. Figs. 10 and 11 are copied from Waagen, 1885, Pl. LXXXV, figs. 2 and 1, respectively.)

Lakhmina linguloides (Waagen), HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 234, figs. 243 and 244. (No text reference. Figs. 243 and 244 are copied from Waagen, 1885, Pl. LXXXV, figs. 5 and 6, respectively.)

Neobolus warthi Waagen, HALL and CLARKE, 1892, idem, p. 245, figs. 250 and 251. (No text reference. Figs. 250 and 251 are copied from Waagen, 1885, Pl. LXXXIV, figs. 6 and 7, respectively.)

Lakhmina linguloides (Waagen), HALL and CLARKE, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, p. 550, figs. 243 and 244. (No text reference. Figs. 243 and 244 are copied from Hall and Clarke, 1892a, figs. 243 and 244, p. 234.)

Neobolus warthi Waagen, HALL and CLARKE, 1892, idem, p. 561, figs. 250 and 251. (No text reference. Figs. 250 and 251 are copied from Hall and Clarke, 1892a, figs. 250 and 251, p. 245.)

Lakhmina linguloides (Waagen), HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 28, figs. 13 and 14. (No text reference. Figs. 13 and 14 are copied from Waagen, 1885, Pl. LXXXV, figs. 5 and 6, respectively.)

Neobolus warthi Waagen, HALL and CLARKE, 1892, idem, p. 84, figs. 39 and 40. (No text reference. Figs. 39 and 40 are copied from Waagen, 1885, Pl. LXXXIV, figs. 6 and 7, respectively.)

Lakhmina linguloides (Waagen), FRECH, 1897, additional plates inserted in 1897, in Lethæa geognostica, pt. 1, Lethæa palæozoica, atlas, 1876, Pl. I A, figs. 4a–b. (Figs. 4a and 4b are copied from Waagen, 1885, Pl. LXXXV, figs. 5 and 6, respectively.)

Neobolus warthi Waagen, FRECH, 1897, idem, Pl. I A, figs. 5a–b. (Figs. 5a and 5b are copied from Waagen, 1885, Pl. LXXXIV, figs. 7 and 4, respectively.)

The generic description embraces the characters of the species. By the courtesy of Dr. T. H. Holland, director Geological Survey of India, I have had the opportunity of studying the type material and thus of coming to an independent opinion as to the genus and species.

Waagen [1885, p. 758] states that the surface of the shell is perfectly smooth. I find that some of the specimens are worn nearly smooth, while others preserve concentric lines and striæ of growth. The shells show the same variation of surface as do shells of *Obolus* that have lived on a sandy bottom and been more or less worn by the attrition of the sand.

The second species of the genus, "*Neobolus wynnei*," differs from the types of *Neobolus warthi*, according to Waagen [1885, p. 760], only in having the surface striæ more distinctly preserved. This character does not appear to be of specific value, as there is considerable variation in this respect among the type specimens of *Neobolus warthi*.

A B

FIGURE 47.—*Neobolus warthi* Waagen. A, Interior of dorsal valve showing area, median ridge, and thickening of the shell beneath the visceral area. On the right side the main vascular sinus is clearly shown. This drawing is from a cast of a dorsal valve in which the platform has not been developed. B, Outline of a platform, median ridge, and vascular sinuses in a dorsal valve, obtained by removing the outer shell by acid (×3). (See p. 565.)

The specimens represented by figures 47A and 47B were collected in the Khussak group of the Middle Cambrian at Kiura (Khewra), Salt Range, India. The specimen represented by figure 47A is shown in Plate 1, fig. 4h, also, the present figure being the correct and later drawing from a cast made in a natural mold. The specimen from which the cast was taken is in the collection of the Geological Survey of India (Cat. No. 3/780).

The relations of *Neobolus warthi* and *Lakhmina linguloides* have been mentioned under observations on the genus *Neobolus* (page 565).

The shell described as "*Davidsonella squama*" by Waagen [1885, p. 766] appears to be a dorsal valve of "*Lakhmina linguloides*." He figures it [1891, Pl. II, figs. 6a–b] as *Neobolus warthi*. I found some rock attached to the cardinal margin in such a manner as to give the effect of a low pointed apex. On clearing the rock away the apex was found to be marginal and the cardinal border the same as in the dorsal valves of "*Lakhmina linguloides*." The shell is the largest found at Jutána. It has a length of 13 mm.; width, 14.5 mm.

The specific name was given in honor of Dr. H. Warth.

FORMATION AND LOCALITY.—**Middle Cambrian**: Lower portion of the "*Neobolus* beds" of the Khussak group, in purplish-colored, fine-grained, micaceous sandstones at the following localities [Waagen, 1885, p. 759]; (**357c**) near the fresh-water springs in a gorge above the salt mines at Kiura (Khewra); (**357a**) *at Jutána*; and (**357b**) at Chél Hill; all in the Salt Range, India.

Subfamily BICIINÆ Walcott and Schuchert.

Genus BICIA Walcott.[a]

Bicia Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 676–678. (Described and discussed as below as a new genus.)
Bicia Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 144. (Classification of genus.)

Shell subequivalve, moderately convex, longitudinally ovate, with the ventral valve sometimes subacuminate and the dorsal valve subcircular. Beak of both valves as now known terminates at the posterior margin. Surface marked by concentric and radiating striæ.

Shell substance unknown in an unaltered condition. Shell structure formed of a thin surface layer and numerous inner layers or lamellæ more or less oblique to the outer layer. Area of the ventral valve usually on the plane of the edges of the valve, but in some instances it rises at a low angle; it is usually high and triangular in outline, but the apex may be rounded and the base curved forward at the median line; divided midway by a narrow pedicle furrow and again at each side by a narrow flexure line that extends forward and outward from the apex. Area of dorsal valve short; it appears in both of the known species to rise from the plane of the edges of the valve. Striæ of growth subparallel to the base across the areas.

The main vascular sinuses of the ventral valve are narrow and extend forward from the projecting center of the base of the area, gradually separating as they cross the visceral area and extend forward beyond the transverse center of the shell. In the dorsal valve they appear to separate more rapidly and to follow the outer margin of the central cavity, except in the second species. A narrow median septum is indicated in the dorsal valve on the crest of a strong median ridge.

One of the striking features in both of the known species of this genus is the oblong oval boss (b) that is present in the ventral valve of most adult shells; it is situated each side of the forward projecting central portion of the area, with the larger axis extending forward and outward when the shell is subacuminate, and transverse when the shell is broadly rounded; in the dorsal valve of *Bicia gemma* (Billings) it is not so well defined as in *B. whiteavesi* Walcott; the boss (b) is bounded by the margin of the base of the area, the narrow elongate sulcus containing the marginal muscle scars and the base of the main vascular sinuses. In *B. whiteavesi* it reaches its greatest development in both valves, resembling in position and surface characters the posterior occlusor scars of *Pholidops implicata* von Huene [1899b, p. 278, Pl. X]. Somewhat similar bosses occur in the ventral valve of *Obolella crassa* (Hall) and *Obolus apollinis* Eichwald, but they are not developed to the extent they are in *Bicia*. They appear to occur only in those thick shells that have deposits of shell substance over the visceral area.

The outline of the parietal scar in the ventral valve is well shown by Plate L, figure 1g; it incloses a heart-shaped visceral area in the ventral valve closely circumscribing the muscle scars; its general course in the dorsal valve is suggested by the position of the muscle scars.

Five pairs of muscle scars have been observed. The rather large central scars (h) in the dorsal valve are placed close to the broad median ridge, a little back of the center; the small anterior laterals (j) are slightly in advance of the centrals on the median ridge, close to the median line; the transmedian scars (i) are almost under the edge of the area and near the outer margin; the outside (l) and middle (k) laterals are slightly in advance and farther out than the transmedian scars. The centrals, middle laterals, and outside laterals of the ventral valve are grouped in the narrow space on each side of the U-shaped forward-projecting portion of the visceral area (c, fig. 2); traces of individual scars have been seen, but they can not be separated so as to identify them; the transmedian (i) and anterior lateral (j) scars are close to the outer margin of the ventral valve and just in advance of the oblong boss in front and each side of the forward-projecting base of the area; umbonal and pedicle scars unknown, except what may possibly be a small umbonal scar in the dorsal valve of *B. whiteavesi* Walcott [Pl. L, fig. 2e, at g].

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[a] Prior to the definition of the genus *Bicia* the type species was described under the following genera:

Obolella Billings [1872a, p. 218; 1872b, p. 357].
Obolella Walcott [1886h, p. 116; 1891a, p. 612].
Obolella Hall and Clarke [1892c, pp. 69 and 71].

Type.—Obolella gemma Billings. Second species: *Bicia whiteavesi* Walcott.

Observations.—Bicia is a form that combines many of the characteristics of *Obolella* and *Obolus*. It resembles *Obolella* in the arrangement of the muscle scars and main vascular sinuses of the interior of the valves. It differs in having a high area with an open pedicle groove in the ventral valve and an elevated ridge or boss in the back portion of the dorsal valve that in one species, *B. whiteavesi*, is very prominent. The ensemble of the dorsal valve of *Bicia* is unlike that of either *Obolella* or *Obolus*. *Bicia* with its thick shell, high area, deep central cavity (heart-shaped cavity of Mickwitz [1896, p. 71]), arrangement of visceral cavity, muscle scars, and vascular markings in the ventral valve, is a true *Obolus* of the *O. apollinis* Eichwald type; but in its more elongate outline, strongly striated surface, and in nearly all details of the dorsal valve it is quite distinct.

Of the two species now referred to the genus, *B. gemma* (Billings) has an unusually thick shell and a very marked deposit of shell substance over the visceral area in the ventral valve, the posterior portion of the same area in the dorsal valve, and along its median line. In the second species there is a considerable deposit over the same area, with the exception of the median line, where the strong median ridge is absent.

The generic name is derived from the town of Bic, Quebec, near which the type species was found.

Bicia gemma (Billings).

Plate L, figures 1, 1a–n.

Obolella gemma Billings, 1872, Canadian Naturalist, 2d ser., vol. 6, No. 2, pp. 218–219; fig. 5, p. 217. (Described and discussed as a new species.)

Obolella gemma Billings, 1872, Am. Jour. Sci., 3d ser., vol. 3, p. 357, fig. 5, p. 355. (Described and discussed. Fig. 5 is copied from fig. 5 of the preceding reference.)

Obolella gemma Billings, Walcott, 1886, Bull. U. S. Geol. Survey No. 30, pp. 116–117, Pl. X, figs. 2, 2a–e. (Copies the original description, Billings, 1872a, pp. 218–219, and discusses species. The specimens represented by Pl. X, figs. 2b, 2c, 2d, and 2e, are redrawn in this monograph, Pl. L, figs. 1i, 1j, 1k, and 1c, respectively.)

Obolella gemma Billings, Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 612, Pl. LXXI, figs. 5, 5a–c, Pl. LXXII, figs. 2 and 2a. (No text reference. Figs. 5, 5a–c are copied from Walcott, 1886b, Pl. X, figs. 2, 2d, 2b, and 2c, respectively; Pl. LXXII, figs. 2 and 2a, are copied from Walcott, 1886b, Pl. X, figs. 2a and 2e, respectively.)

Obolella gemma Billings, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 69 and 71; fig. 30, p. 71; and Pl. II, figs. 42–44. (Discussed under the genus *Obolella*. Fig. 30, p. 71, is copied from Walcott, 1886b, Pl. X, fig. 2d; Pl. II, fig. 42, is drawn from the specimen figured by Walcott, 1886b, Pl. X, fig. 2a.)

Bicia gemma (Billings), Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 678–680. (Described and discussed as below.)

General form ovate, with ventral valve subacuminate when the beak is extended, or obtusely acuminate when the beak is rounded; dorsal valve oval to subcircular in outline; the range of variation in the outline of the valves is shown by the figures on Plate L. The convexity of the valves is fairly strong and nearly the same in each where they are embedded in the same matrix.

Surface of shell marked by numerous slightly irregular concentric striæ and lines of growth, by fine radiating striæ between stronger radiating lines, and on some shells by strongly developed, elevated, radiating striæ; the radiating striæ are often slightly irregular and interrupted, as shown by figure 1a. When the outer surface is partly worn away it is smooth, or the shell has a peculiar surface formed by traces of the radiating, interrupted, or undulating striæ (fig. 1d). The concentric striæ and lines of growth are shown on the outer surface of the inner layers of the shell and on the interior surface where rather strong radiating striæ are often beautifully shown.

The shell is unusually thick and strong for one so small; those from St. Simon and Troy appear to be calcareous and formed of one solid layer; this is probably owing to their condition of preservation, as in a weathered specimen lamellæ oblique to the outer surface are clearly shown, and indications of lamellæ on the central and posterior portions point to the same shell structure as in *Obolus* and *Obolella*.

The ventral valves average about 5 mm. in length, the largest being 7 mm.; average width 4 mm., largest 5 mm. The dorsal valve is about one-fifth shorter than the ventral.

The area of the ventral valve is usually on the plane of the margins of the valve, but in many specimens it rises at angles varying from 1° to 10°; it is high and narrow, somewhat as in *Obolus* (*Schmidtia*) *acuminatus* Mickwitz (Pl. XIV, figs. 2, 2a) and divided midway by a strong, rounded, narrow pedicle furrow; the striæ of growth are rather coarse and arch forward at the center and across the pedicle furrow, following the contour of the base of the area; the position of the flexure line is sometimes clearly shown by a narrow depression. The area of the dorsal valve is short and easily escapes observation except in well-preserved shells; it sometimes has a slight central pedicle depression and often is only a short, almost smooth surface extending well out on the cardinal slopes of the valve.

The muscle scars as far as determined are arranged as in *Obolus*. The umbonal and pedicle scars have not been observed. The elongate, oval central scars (h) are rather large in the dorsal valve and situated on each side of the strong median ridge about the middle of the valve; in the ventral valve they are crowded in with the scars of the middle and outside laterals; the anterior laterals (j) are barely discernible in one specimen of the dorsal valve as small oval dots on the central ridge a short distance in advance of the centrals; in the ventral valve they are close to the base of the area and near the outer edge of the shell; the middle and outside laterals in the ventral valve are situated in the trapezoidal area (c), but do not appear to be separable on the specimens in the collection; in the dorsal valve they are well shown in advance of the transmedian scar (i). The latter (i) in the ventral valve is merged with the anterior laterals (j).

Of the vascular markings the main sinuses of the ventral valve are about all that is clearly shown, although the position of the parietal scar is indicated in advance of the center of the shell (fig. 1g). One of the most strongly marked characters of the dorsal valve is the median ridge (mr); it varies in strength and outline in different shells, but is usually a prominent feature; it extends to the frontal margin in most shells, but in some it narrows and is less prominent anteriorly. A few specimens show a slight depression crossing it just in front of the central scars, and one has two minute anterior lateral muscle scars directly on the ridge, the parietal scar passing across just in front of them. The thickened shell beneath the visceral cavity of the ventral valve is present in nearly all adult shells; it varies greatly in size, form, and thickness; in some valves it covers the entire area within the parietal scar (Pl. L, figs. 1h and 1k), and in others only a portion (Pl. L, fig. 1i). The thickening in the dorsal valve is along the posterior border of the central cavity; this is best shown in the cast (Pl. L, fig. 1 l). The median ridge is also frequently more or less enlarged.

Formation and locality.—**Lower Cambrian**: (2o) Limestone bowlders in conglomerate on shore at east entrance to harbor at Bic, Rimouski County; (2p) limestone on south side of the road a little west of Bic, and half mile (0.8 km.) west of the road leading to the wharf, Rimouski County; and (319b) limestone bowlders in conglomerate at St. Simon, Rimouski (?) County; all in the Province of Quebec, Canada.

(392c [*Billings, 1872a, p. 218*]) *At the Straits of Belleisle, Labrador.*

(32a) Limestone 0.75 mile (1.2 km.) west of Riders Mills on the Harlem Extension Railroad, about 9 miles (14.4 km.) north-northeast of Chatham, Kinderhook quadrangle (U. S. Geol. Survey), Columbia County; (27) even-bedded and conglomeratic limestones on the ridge in the eastern suburb of Troy, Rensselaer County; (29a) limestone 1 mile (1.6 km.) below the New York Central Railroad depot at Schodack, Rensselaer County; and (2b) limestone just north of Beman Park, in the northeastern part of the city of Troy, Troy quadrangle (U. S. Geol. Survey), Rensselaer County; all in New York.

Bicia whiteavesi Walcott.

Plate L, figures 2, 2a–e.

Bicia whiteavesi Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 680. (Characterized and discussed as below as a new species.)

This species is associated with *Bicia gemma* (Billings) in a bedded limestone at Troy, New York. It differs from the latter, in the dorsal valve, in the absence of the median ridge; the presence of a broad area; in the presence in the interior of both valves of two large,

circular, scarlike spots, one on each side of the median line and just in front of the area, that recall in appearance and position the posterior adductor scars of *Crania*. The ventral valve is so much like that of *B. gemma* (Billings) that it is difficult to decide whether such shells as are represented by Plate L, figures 2a and 2b, should not be referred to *B. gemma*. There is a gradual transition in form and character of the interior of the ventral valve between the extremes represented in *B. gemma* by figures 1h and 1i, through figures 1f, 1g, 1k, 2a, and 2b, to the extreme form of *B. whiteavesi*, figure 2c. If it had not been for the bosses in figure 2c, and the dorsal valve, figure 2e, associated with it, I would have hesitated to refer it to a distinct species.

The specific name is given in honor of Prof. J. F. Whiteaves, of the Geological Survey of Canada.

FORMATION AND LOCALITY.—**Lower Cambrian:** (2b) Limestone just north of Beman Park, in the northeastern part of the city of Troy, Troy quadrangle (U. S. Geol. Survey), Rensselaer County, New York.

Genus DICELLOMUS Hall.[a]

Dicellomus HALL, 1873, Twenty-third Ann. Rept. New York State Cab. Nat. Hist., p. 246. (Characterized as a new genus.)

Schmidtia ZITTEL (in part) [not VOLBORTH], 1880, Handbuch der Palæontologie, Bd. 1, Abth. 1, p. 665. (Doubtfully places *Dicellomus* as a synonym of *Schmidtia*.)

Obolella Billings, HALL and CLARKE (in part), 1892, Eleventh Ann. Rept. State Geologist New York for 1891, pp. 240–241. (*Dicellomus* is included with *Obolella* as a synonym.)

Obolella Billings, HALL and CLARKE (in part), 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, pp. 556–557. (Copy of preceding reference.)

Obolella Billings, HALL and CLARKE (in part), 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 66–73, especially pp. 72–73. (*Dicellomus* is discussed as a synonym of *Obolella*.)

Dicellomus Hall, WALCOTT, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, p. 446. (Discussed, part of the paragraph being copied below, see p. 572.)

Dicellomus Hall, WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 312–313. (Described and discussed essentially as below.)

Dicellomus Hall, GRABAU and SHIMER, 1907, North American Index Fossils, vol. 1, p. 189. (Described.)

Dicellomus Hall, WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 144. (Classification of genus.)

Shell small; general form ovate to subsemicircular, biconvex, with apices marginal. Surface of outer shell finely punctate in all species where it is preserved uninjured. Interior or middle lamellæ marked by radiating striæ and minute punctæ; inner surface finely punctate. The shell is thick in all the species now known, and is built up of a thin, outer, scabrous layer, numerous inner layers or lamellæ, and a thin inner layer. Shell substance apparently calcareo-corneous.

The interior of the ventral valve (Pl. LII, figs. 1c, 1d) shows a short area with a median pedicle groove; an elongate visceral area; well-marked main vascular sinuses; large, composite scars (cl) where the posterior muscles, i. e., transmedian and outside and anterior laterals, were attached; and a short shelf that extended into the valve from each side of the pedicle groove. This extension appears to correspond to the dental plate in the articulate brachiopods, and it has a slight thickening at the anterolateral margin that suggests a short tooth. In material received from Prof. W. A. Finkelnburg from Hudson, Wisconsin, I worked out several interiors of the ventral valve and found in all of them more or less of the remains of a lining of the pedicle

[a] The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Dicellomus* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Obolus Owen [1852, p. 501].
Lingula Hall [1861, p. 24].
Obolella Billings [1861b, p. 7; 1861c, p. 946].
Lingula Hall [1862, p. 435].
Obolella Billings [1862c, p. 421; 1862d, p. 67; 1862e, p. 218].
Obolella Meek and Hayden [1862, p. 435].
Obolella Hayden [1862, p. 73].
Lingula Whitfield [1862, p. 136].
Obolella? Hall [1863, p. 133].
Lingulepis Meek and Hayden [1865, p. 3].
Obolella Meek and Hayden [1865, p. 4].
Obolella? Hall [1867, p. 112].
Obolus Whitfield [1875, p. 103].
Obolus? Whitfield [1880, p. 338].
Obolella Whitfield [1880, pp. 339 and 340].
Obolella Walcott [1886b, p. 111].
Obolella Schuchert [1897, p. 275].
Dicellomus Walcott [1901, p. 673; 1908d, p. 77].

tube that extended on each side above the plane of the cardinal area so as to form a concave plate similar to the posterior portion of the spondylium in *Syntrophia* (Pl. CII, fig. 6f). If the sides of the plate were extended farther and united about the pedicle, a tube would result similar to that of *Obolella* (Pl. LV, figs. 1f and 1h), and ultimately to that of *Botsfordia* (Pl. LVII, figs. 4c and 4g). This plate in *Dicellomus*, while suggesting a spondylium, is more naturally interpreted as the beginning of a pedicle tube.

The interior of the dorsal valve has a well defined but very narrow area in one species, *D. politus* (Hall), that is hollowed out so as to form a shallow groove on each side, apparently for the reception of the short tooth of the ventral valve. No good posterior margins of the valve could be found of the other species of the genus. The composite scar is large, and in one shell it is subdivided into three small scars that were the points of attachment of the transmedian and outside and middle laterals. The central and anterior lateral scars are arranged as in *Obolus;* the centrals are large and located on the sides of the visceral area; the anterior laterals are small and are located at the anterior end of the visceral area.

Type.—Lingula polita Hall.

Observations.—When referring to *Dicellomus* in 1899 I said [1899, p. 446]:

> When proposing that the genus *Dicellomus* include *Obolella polita*, Professor Hall [1873, p. 246] stated that the grooving or emargination of the apices of both valves and the thickening of the edges of the shell on each side below the apex, together with the form and character of the muscular impressions, would separate the species from *Obolella*. Again, Messrs. Hall and Clarke [1892c, p. 72] gave a fuller description of *Dicellomus politus*, but owing to the poor character of the material they did not feel confident that it should be recognized as generically distinct from *Obolella chromatica*. Material now in the collections of the United States Geological Survey clearly shows that Professor Hall's provisional conclusion was correct, and that *Dicellomus politus* is generically distinct from *Obolella chromatica*.

The presence of the large, composite, cardinal muscle scars in each valve suggests that a search be made for a foraminal opening, as in *Obolella, Linnarssonella,* and *Acrotreta.* No trace has been found externally, and the interior of the ventral valve does not show evidence of it, except in the pedicle plate. *Dicellomus* appears to include characteristics of *Obolus* and *Obolella,* and the presence of incipient dental plates, teeth, and dental grooves suggests an articulate shell.

Dicellomus appalachia Walcott.

Plate LIII, figures 4, 4a–g.

Dicellomus appalachia Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 314. (Described and discussed as below as a new species.)

This shell has been identified with *D. politus* (Hall) in the preliminary studies of the genus *Dicellomus.* I find that while it has the same type of shell structure and general form, it differs in being less elongate proportionally and in the details of the form and positions of the muscle scars and vascular markings of the interior of the valve; it differs in the latter respect from *D. nanus* (Meek and Hayden). The outer thin layer has a dull, finely roughened surface that is minutely punctate. When the outer layer is exfoliated the surface of the layer beneath is highly polished and marked by exceedingly fine radiating and concentric striæ and lines of growth. The interior of the dorsal valve shows the large central muscle scars with the minute anterolateral scars almost in contact with them. A composite scar (cl, Pl. LIII, fig. 4d) shows the separate points of attachment of the transmedian (i), outside lateral (l), and middle lateral (k) scars. The variation in the length of the visceral cavity of the dorsal valve, as shown in Plate LIII, figures 4d to 4g, is very great, and it may be that figures 4f and 4g belong to another species.

This species occurs in great abundance in both limestones and shales. It is the Appalachian representative of the widely distributed *D. politus* of the interior of the continent, hence the specific name.

Formation and locality.—**Middle Cambrian**: (2z) Nolichucky (?) shale [Campbell, 1899, p. 3], near Shipley Ferry, 0.75 mile (1.2 km.) northwest of Bethany Chapel, northeastern corner of the Roan Mountain quadrangle (U. S. Geol. Survey); (2z′) shales in the Honaker limestone [Campbell, 1899, p. 3], at Wallace switch, about 5 miles (8 km.) northeast of Bristol, Bristol quadrangle (U. S. Geol. Survey); and (374c) sandy shale (Nolichucky?) [Campbell, 1899,

p. 3], 8 miles (12.8 km.) northeast of Shipleys, near the line between the Roan Mountain and Bristol quadrangles (U. S. Geol. Survey); all in Sullivan County, Tennessee.

(**103a**) Upper part of the second shale south of the ridge of sandstone in the Rome formation ("Town Knobs"), on the road from Rogersville to Dodson Ford, near the line between the Morristown and Greeneville quadrangles (U. S. Geol. Survey); (**102**) Rogersville shale just south of road, one-half mile (0.8 km.) southwest of Rogersville, on the road to Melinda Ferry [Keith, 1896a, areal geology sheet]; (**104**) shale in railroad cut 0.5 mile (0.8 km.) from Rogersville on the road to Holston River, near the line between the Morristown and Greeneville quadrangles (U. S. Geol. Survey); (**124a**) shale (Nolichucky?) overlying the limestone which rests on the Rogersville shale, on Big Creek, southeast of Harlan Knob, 4 miles (6.4 km.) northeast of Rogersville [see Keith, 1905, p. 4, and areal geology sheet]; and (**374b**) shale 1.25 miles (2 km.) from Rogersville, near the line between the Morristown and Greeneville quadrangles (U. S. Geol. Survey); all in Hawkins County, Tennessee.

(**107**) Limestone in Bull Run; and (**107b**) shales in railroad cut in Bull Run; both northwest of Copper Ridge [Keith, 1896b, areal geology sheet], 11 miles (17.6 km.) northwest of Knoxville, Knox County, Tennessee.

(**11a**) Sandstone between First and Armstrong creeks, in the southeast corner of the Maynardville quadrangle (U. S. Geol. Survey), Union County; (**117c**) shale at Buckingham Ford on Hollis Creek, 5 miles (8 km.) southeast of Greeneville, Greene County; (**374a**) limestones 2 miles (3.2 km.) south of Coal Creek, Anderson County; and (**119**) limestone in various localities in Jefferson and Hawkins counties; all in Tennessee.

(**16**) Conasauga limestone, Blountsville Valley, Blount County; (**89**) *limestone in Murphrees Valley, Blount County;* (**90a**) shales at Cedar Bluff, Cherokee County; (**90b**) Conasauga limestone, in cut on Louisville and Nashville Railroad, near Woodstock, Bibb County; (**144c**) limestone near the top of the beds exposed near N. K. Burns's barns, near Swansea (Viola), Blount County; and (**91**) Conasauga ("Coosa") shale, at Cedar Bluff, Cherokee County; all in Alabama.

(**47h**) Shales on Wolf Creek, 6 miles (9.6 km.) below Rocky Gap, Bland County, Virginia.

Dicellomus nanus (Meek and Hayden).

Plate LIII, figures 1, 1a–l, 2, 2a, 3, 3a–d.

Obolella nana Meek and Hayden, 1862, Proc. Acad. Nat. Sci. Philadelphia for 1861, vol. 13, pp. 435–436. (Described and discussed as a new species.)

Obolella nana Meek and Hayden, Hayden, 1862, Am. Jour. Sci., 2d ser., vol. 33, p. 73, figs. 1a–b and 2a–b. (Characterized and discussed. The two specimens represented by figs. 2a and 2b are redrawn in this monograph, Pl. LIII, figs. 2a and 2, respectively.)

Obolella nana Meek and Hayden, Billings, 1862, Geol. Survey Canada, Paleozoic Fossils, vol. I, pp. 67–68. (Original reference, Meek and Hayden, 1862, pp. 435–436, copied.)

Obolella nana Meek and Hayden, 1865, Smithsonian Contrib. Knowl., No. 172, Paleontology Upper Missouri, pt. 1, p. 4, Pl. I, figs. 3a–d. (Described and discussed. Figs. 3a–b and 3c–d are copied from Hayden, 1862, p. 73, figs. 2a and 2b, respectively.)

Obolella nana Meek and Hayden, Whitfield, 1880, U. S. Geog. and Geol. Survey Rocky Mtn. Region, Rept. Geology and Resources Black Hills of Dakota, by Newton and Jenney, pp. 340–341, Pl. II, figs. 14–17. (Copies the description given by Meek and Hayden, 1865, p. 4, and discusses species. Fig. 17 is copied from Meek and Hayden, 1865, Pl. I, fig. 3d.)

Obolella nana Meek and Hayden, Walcott, 1886, Bull. U. S. Geol. Survey No. 30, p. 111. (Discussed.)

Obolella nana Meek and Hayden, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 69–70. (Discussed.)

Dicellomus nanus (Meek and Hayden), Walcott (in part), 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, p. 447, Pl. LX, figs. 3a–d (not fig. 3). (Synonymy and new localities given. Figs. 3b and 3d are drawn from the specimens figured by Hayden, 1862, p. 73, figs. 2a and 2b, and are redrawn in this monograph, Pl. LIII, figs. 2a and 2, respectively. The specimens represented by figs. 3a and 3c are not figured in this monograph. The specimen represented by fig. 3 is referred in this monograph to *Lingulella desiderata*.)

Dicellomus nanus (Meek and Hayden), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 314–315. (Described and discussed essentially as below.)

The principal characters of this species are the same as *Dicellomus politus* (Hall). The two forms differ exteriorly in *D. nanus* being more convex on the umbones and less elongate. The interior of the ventral valve shows a less elongate visceral area, a relatively larger composite muscle scar (cl); the interior of the dorsal valve of *D. nanus* has a much larger composite muscle scar and a broader visceral area with the central muscle scar farther from the median line.

One of the types of *D. nanus* is the interior of a ventral valve (Pl. LIII, fig. 2), on which there is a subtriangular depression (c) that appears to have been the path of advance of the areas, on each side of the median space, in which the central muscle, and the middle and outside

lateral muscles, were attached. Another shell from the Bighorn Mountains shows something of the same character (Pl. LIII, fig. 11).

The area of the ventral valve is short, and divided midway by a shallow pedicle furrow; area of dorsal valve unknown.

The exterior of the shell appears to be smooth and slightly polished, except for fine concentric striæ and lines of growth and what appear to be scattered punctæ.

The average size of the adult shells is from 3 to 4 mm., the length and width usually being nearly the same.

The exact horizon of the type specimen is unknown. It occurs in a somewhat friable, purplish sandstone, unlike any beds in the Middle Cambrian Deadwood formation that I met with. The specimens from the limestones of the Bighorn Mountains, etc., appear to belong to the Upper Cambrian.

FORMATION AND LOCALITY.—**Ordovician**: (**302v**) Sandstones 2 miles (3.2 km.) west of the main summit of Buffalo Fork Peak [St. John, 1877, pp. 468 and 469 and map opposite p. 324 (near station XLIX)], about 25 miles (40 km.) east of Jackson Lake, Uinta County, Wyoming.

Upper Cambrian: (**152a**) West side of Dry Creek below Pass Creek; and (**158a**) limestone north of East Gallatin River near Hillsdale; both in the Threeforks quadrangle (U. S. Geol. Survey), Gallatin County, Montana.

(**302u**) Upper limestone of the Deadwood formation, north of Cheever's ranch, on the summit of the Bighorn Mountains, Wyoming.

Middle Cambrian: (**170**) Sandstone about 10 miles (16.1 km.) south-southeast of Bald Mountain, Bighorn Mountains; (**302m**) middle of shale above lower sandstone on Billy Creek in the Bighorn Mountains; (**302y**) sandstone on Johnson Creek, Bighorn Mountains; and (**302b**) limestones near Crowfoot Ridge, Gallatin quadrangle (U. S. Geol. Survey), Yellowstone National Park; all in Wyoming.

(**302z**) Limestone on Mill Creek, near Landusky, Little Rocky Mountains, Chouteau County, Montana.

(**355**) Sandstones on Red Canyon Creek, southwest side of Black Hills; and (**355d**) *sandstone in the Black Hills;* both in South Dakota.

(**11j**) Basal part of Bonneterre limestone, Mine Lamotte, Madison County; and (**11m**) drill cores of limestone at horizons 10 and 20 feet (3 and 6 m.) above the Lamotte sandstone, St. Francois County; both in Missouri.

DICELLOMUS PARVUS Walcott.

Plate LXXXIX, figures 11, 11a–d.

Dicellomus parvus WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 315–316. (Described and discussed as below as a new species.)

General form ovate, with the ventral valve subacuminate and dorsal valve broad oval to subcircular. Valves moderately convex. Surface of outer shell dark and polished; it is marked, when not abraded, by fine, clearly defined, concentric striæ and occasional lines of growth. The largest ventral valve has a length of 2.5 mm. and a width of 2 mm. The shell is strong but not thick. Shell substance apparently calcareocorneous.

Ventral valve uniformly convex, except that the slopes toward the cardinal margins are more abrupt than elsewhere; apex appears to be marginal. The interior of the valve shows a short, low, median ridge in the center of the visceral cavity; on each side, and a little in front of the end of the median ridge are the trapezoidal areas for the attachment of muscle scars; rather small, composite cardinal muscle scars occur close to the cardinal margins.

Dorsal valve somewhat less convex than the ventral; apex marginal. The interior of the valve shows well-defined composite cardinal muscle scars, a narrow median septum, and a faintly impressed main vascular sinus that curves outward and forward at about one-third the distance from the outer margin to the median septum; the central muscle scars are small and situated back of the center of the valve on each side of a low median swelling on which the median septum occurs; the position of the anterior lateral muscle scars is indicated at the end of the median septum a little in advance of the center of the valve.

Observations.—This minute shell has the generic characters of *Dicellomus politus* (Hall), but it differs specifically in its minute size and the positions of the muscle scars in the dorsal valve.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**C6**) *Thin slabby limestone in the upper shale member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 41 (2d list of fossils), and fig. 10 (bed 12), p. 38], 2.5 miles (4 km.) southwest of*

Yenchuang, Sintai district, Shantung; and (**C32**) a fine-grained bluish-black limestone bowlder believed to have come from the lower part of the Kisinling limestone [Blackwelder, 1907b, p. 272], collected in river drift 1 mile (1.6 km.) south of Chonpinghien, on Nankiang River, southern Shensi; both in China.

Dicellomus pectenoides (Whitfield).

Text figures 48A–B; Plate LII, figures 6, 6a–c.

Obolus pectenoides Whitfield, 1875, Rept. Reconnaissance Black Hills of Dakota, by Ludlow, p. 103, unnumbered plate, figs. 1–3. (Described and discussed as a new species.)

Obolus? pectenoides Whitfield, 1880, U. S. Geog. and Geol. Survey Rocky Mtn. Region, Rept. Geology and Resources Black Hills of Dakota, by Newton and Jenney, pp. 338–339, Pl. II, figs. 18 and 19. (Described. The specimens represented by figs. 18 and 19 are redrawn in this monograph, Pl. LII, figs. 6 and 6a, respectively.)

Obolella pectenoides (Whitfield), Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 275. (Merely changes generic reference.)

Dicellomus pectenoides (Whitfield), Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 673. (Merely changes generic reference.)

Dicellomus pectenoides (Whitfield), Walcott, 1905, idem, vol. 28, p. 316. (Characterized.)

This is the largest shell of the several species of the genus. A ventral valve 9 mm. long has a width of 11 mm. All that is known of the structure of the shell indicates that it was like *D. politus* (Hall) (Pl. LII) and *D. nanus* (Meek and Hayden) (Pl. LIII). This species differs from all other described species by the anterior position of the central muscle scars of the dorsal valve, its larger size, and the thickening beneath the visceral cavity of the ventral valve. Area of ventral valve short and much like that of *D. nanus* (Pl. LIII, fig. 1c). Specimens from Eau Claire, Wisconsin, show a thickening of the shell beneath the visceral cavity of the ventral valve not unlike that of *Elkania desiderata* (Billings) (Pl. LI, fig. 1a). The interior of the dorsal valve is quite dissimilar in the two species.

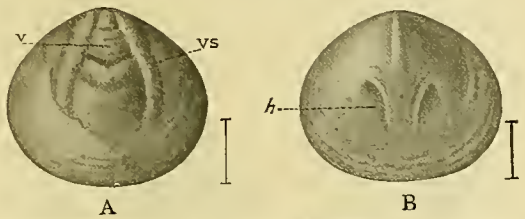


Figure 48.—*Dicellomus pectenoides* (Whitfield). A, Cast of interior of ventral valve from Locality **78a**, "St. Croix sandstone" at Eau Claire, Wisconsin (U. S. Nat. Mus. Cat. No. 51909). B, Cast of interior of dorsal valve from Locality **100**, "St. Croix sandstone" at Menomonie, Dunn County, Wisconsin (U. S. Nat. Mus. Cat. No. 51910). v, Visceral cavity; vs, main vascular sinuses; h, central muscle scars.

Formation and locality.—**Upper Cambrian:** (**151a**) Limestone in point overlooking Churn Canyon, on the west side of the Bridger Range; and (**158**) limestone north of East Gallatin River near Hillsdale, Threeforks quadrangle (U. S. Geol. Survey); both in Gallatin County, Montana.

(**78a**) "St. Croix sandstone" in the topmost quarry on Mount Washington, near Eau Claire, Eau Claire County; and (**100**) "St. Croix sandstone" near Menomonie, Dunn County; both in Wisconsin.

Middle Cambrian: (**355b**) Sandstone in the Deadwood formation on Castle Creek, on the west side of the Black Hills; and (**164**) sandstone in the Deadwood formation in the cliffs on the east side of the valley near Deadwood, Black Hills; both in South Dakota.

(**355c** [*Whitfield, 1875, p. 103*]) *Sandstone on French Creek, Black Hills, South Dakota.*

Dicellomus politus (Hall).

Text figures 16A–B, page 314; 49A–B, page 576;[a] Plate LII, figures 1, 1a–k, 2, 2a–i, 3, 4, 4a, 5, 5a–b.

Obolus appolinus? Owen (not Eichwald), 1852, Rept. Geol. Survey Wisconsin, Iowa, and Minnesota, Appendix, p. 501, Pl. I B, figs. 9, 11, 15, and 20. (Occurrence mentioned.)

Lingula polita Hall, 1861, Rept. Supt. Geol. Survey Wisconsin, p. 24. (Described and discussed.)

Obolella sp. 3 Billings, 1861, Geol. Survey Canada, Paleozoic Fossils, vol. 1, p. 7. (Characterized.)

Obolella sp. 3 Billings, 1861, Report on the Geology of Vermont, vol. 2, p. 946. (Copy of preceding reference.)

Lingula? polita Hall, 1862, Rept. Geol. Survey Wisconsin, vol. 1, p. 435, fig. 1, p. 21. (Generic reference discussed.)

Obolella polita (Hall), Billings, 1862, Am. Jour. Sci., 2d ser., vol. 33, p. 421. (Note on the dates of publication of the references cited above, Hall, 1861, p. 24, and Billings, 1861, p. 7.)

Obolella sp. 3 Billings, 1862, Report on the Economic Geology of Vermont, by Hager, p. 218. (Copy of Billings, 1861b, p. 7.)

Lingula polita Hall, Whitfield, 1862, Am. Jour. Sci., 2d ser., vol. 34, p. 136. (Note on the date of the first reference to *Lingula polita*.)

Obolella? polita Hall, 1863, Sixteenth Ann. Rept. New York State Cab. Nat. Hist., pp. 133–134, Pl. VI, figs. 17–21. (Described and discussed.)

[a] Text figures 16A–B and 49A–B are the same.

Lingulepis prima Meek and Hayden, 1865, Smithsonian Contrib. Knowl., No. 172, Paleontology Upper Missouri, pt. 1, p. 3, Pl. 1, figs. 2a–b. (Described and discussed as a new species. The specimen represented by figs. 2a and 2b is redrawn in this monograph, Pl. LII, fig. 2h.)

Obolella? polita Hall, 1867, Trans. Albany Inst., vol. 5, pp. 112–113, Pl. I, figs. 17–21. (Text and figures copied from Hall, 1863, pp. 133–134, Pl. VI, figs. 17–21.)

Dicellomus polita Hall, 1873, Twenty-third Ann. Rept. New York State Cab. Nat. Hist., p. 246. (Changes generic reference.)

Obolella polita (Hall), Whitfield, 1880, U. S. Geog. and Geol. Survey Rocky Mtn. Region, Rept. Geology and Resources Black Hills of Dakota, by Newton and Jenney, pp. 339–340, Pl. II, figs. 12 and 13. (Described and discussed. The specimen represented by fig. 13 is redrawn in this monograph, Pl. LII, fig. 2g; fig. 12 is not.)

Obolella polita (Hall), Walcott, 1886, Bull. U. S. Geol. Survey No. 30, p. 111. (Discussed.)

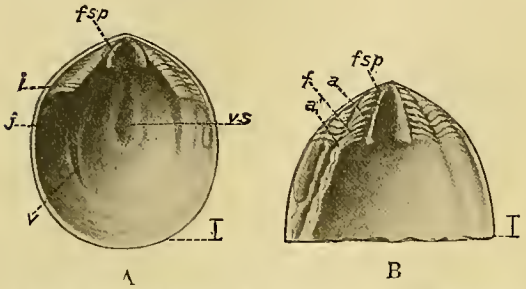
Obolella polita (Hall), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 72 and 73, Pl. II, figs. 37–41. (Discussed as a species of *Dicellomus*, but the use of that term is held in abeyance until the species shall have been proven generically distinct from *Obolella*. Figs. 40 and 41 are copied from Hall, 1863, Pl. VI, figs. 20 and 21.)

Dicellomus politus (Hall), Walcott, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, pp. 443 and 446, Pl. LX, figs. 4 and 4a. (Discussed, establishing the generic distinctness of *Dicellomus*. The specimens represented by figs. 4 and 4a are redrawn in this monograph, Pl. LII, figs. 1j and 1c, respectively.)

Dicellomus politus (Hall), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 313. (Copy of text referred to in preceding reference.)

Dicellomus politus (Hall), Walcott, 1905, idem, pp. 316–318. (Described and discussed as below, although some changes and additions have been made.)

Dicellomus politus (Hall), Grabau and Shimer, 1907, North American Index Fossils, vol. 1, pp. 189–190, fig. 224, p. 190. (Described. The three figures in fig. 224 are copied from Hall, 1863, Pl. VI, figs. 17, 20, and 21.)



A B

Figure 49.—*Dicellomus politus* (Hall). A, Interior of ventral valve (fsp, pseudospondylium or pedicle plate; i, transmedian scars; j, anterolateral scars; v, visceral cavity; vs, main vascular sinuses). B, Posterior portion of the interior of a ventral valve, showing a strongly developed area (fsp, pseudospondylium or pedicle plate; a, inside section of area; f, flexure line; a', outside section of area).

The specimens represented by figures 49A and 49B are from Locality 79s, Upper Cambrian "St. Croix sandstone" at Hudson, Wisconsin (U. S. Nat. Mus. Cat. Nos. 51917a and 51917b, respectively). The same figures are reproduced on page 314.

General form ovate, with the ventral valve subacuminate; biconvex, the ventral valve usually more convex than the dorsal. Surface smooth as the specimens usually occur, but a few examples show that there is a thin outer layer covered with fine papillæ and punctæ that appear to be placed on very fine, more or less inosculating ridges. Concentric lines of growth of varying strength show on the outer surface, also on the various inner layers or lamellæ. When the outer layer is exfoliated or worn off by attrition of the sand, the surface of the inner layer is marked by radiating striæ and concentric lines of growth that are a marked feature of the species. The radiating striæ may be uniform in size, or with 4 to 6 very fine striæ between two stronger elevated striæ. Inner surface smooth to the eye, but a strong lens shows that it is finely punctate, with exceedingly fine, irregular, raised lines all over the surface. The intermediate layer is more coarsely and irregularly punctate.

The shell is thick, and is built up of a thin, scabrous, outer layer, a middle layer made up of several highly polished lamellæ, and a thin inner layer. The numerous inner lamellæ are oblique to the outer surface over much of the shell, and thus give it thickness. Shell substance calcareocorneous. The usual length of the ventral valves from Wisconsin is about 6 mm., width 5 mm., with the same width and length for the dorsal valve. Specimens from the Black Hills average a trifle larger than those from Wisconsin.

Ventral valve with a uniform convexity over the central portions, from which the surface slopes gently to the margins. Apex nearly if not quite marginal. Casts of the interior indicate a short cardinal area that extends out on the cardinal margins of the shell and appears to merge into the margins. On each side of the pedicle furrow a thin plate or shelf (sh) extended into the valve on the plane of the margins of the shell. Some of the casts indicate that these

plates had a projecting boss or tooth that articulated in a rude manner with the depressions on the posterior, flattened, inner margin of the dorsal valve. If this interpretation is correct the teeth and plates correspond to the teeth and dental plates of the articulate brachiopods and the plates may mark the beginning of a spondylium.

A number of interiors from Hudson, Wisconsin, show a concave plate in the pedicle furrow, the edges of which rise above the plane of the cardinal area; this plate is evidently the beginning in *Dicellomus* of the pedicle tube, as shown in *Obolella* (Pl. LV, figs. 1e, 1f, and 1h). In some shells the plate appears to extend into the shell beyond the anterior margin of the cardinal area and it then has the appearance of a small spondylium. I think, however, that it is only the secretion of shelly matter about the pedicle and not connected with the development of a spondylium; the latter is indicated by the extension of the toothlike processes already referred to.

The posterior lateral, transmedian, and anterior lateral muscles were undoubtedly attached within the area of the composite scar (cl) (Pl. LII). The visceral area and posterior portions of the main vascular sinuses are well outlined, but no muscle scars or details of the vascular system have been preserved in the material studied.

Dorsal valve most convex back of the center. Apex marginal. The interior of the valve shows shallow depressions in the flattened posterior margin (a) that suggest dental cavities for the reception of the dental projections of the ventral valve. The central muscle scars (h) are shown a little back of the center of the valve, where a low median ridge bifurcates (Pl. LII, fig. 1i). In some shells a sharp median septum is shown, also narrow main vascular sinuses.

Observations.—The reference to this species of the specimens from the siliceous shale at Helena is rather doubtful, as the shells are compressed and distorted. (See Pl. LII, figs. 4 and 4a.)

Shells agreeing with *D. politus* in all points available for comparison occur in the basal, probably Middle Cambrian, sandstone beneath the great limestone series of Arizona. The material is abundant and preserved very much in the same condition as that from the Deadwood formation of the Black Hills of South Dakota.

In sandstones in the basal part of the Upper Cambrian Reagan sandstone in Oklahoma a few shells were found that appear to be identical with *D. politus*. They have the elongate form of that species, which is unknown in any other species of the genus.

In the collections made by the Fortieth Parallel Survey there are specimens so closely resembling *D. politus* that they are identified as such, although the dorsal valve is rather transverse.

Dicellomus politus differs from *D. nanus* (Meek and Hayden) and *D. pectenoides* (Whitfield) in being more elongate, also in the details of the interior markings of the valves. From *D. appalachia* Walcott it differs in interior markings, and, as specimens average, in being more elongate.

FORMATION AND LOCALITY.—**Upper Cambrian:** (82b) "St. Croix sandstone" along the railroad track near Taylors Falls, Chisago County; (97 and S97x) "St. Croix sandstone" at Reads Landing, foot of Lake Pepin, Wabasha County; (339i) [*Owen, 1852, desc. of Pl. IB*] *sandstones of F1b of Owen's section, below Mountain Island, in Mississippi River, nearly opposite the old mouth of Black River;* and (98a) "St. Croix sandstone" at Marine Mills, on St. Croix River, Washington County; all in Minnesota.

(78a) "St. Croix sandstone" in the topmost quarry on Mount Washington, near Eau Claire, Eau Claire County; and (98 and 98x) "St. Croix sandstone" near Eau Claire, Eau Claire County; (79s) "St. Croix sandstone" in bluff near Hudson, St. Croix County; (328c) "St. Croix sandstone" at Alma, Buffalo County; (83) "St. Croix sandstone" near Trempealeau, Trempealeau County; (100a) "St. Croix sandstone" at Ettrick, Trempealeau County; (80) "St. Croix sandstone" 0.66 mile (1.1 km.) southwest of the railway depot, Menomonie, Dunn County; and (100) "St. Croix sandstone" near Menomonie, Dunn County; all in Wisconsin.

(128a) Shales on the Louisville and Nashville Railroad, 1.5 miles (2.4 km.) southeast of Cog Hill, near the line between Polk and McMinn counties, Tennessee.

(9x) Sandstones lying between beds of quartzite underlying the 300 feet of limestone at the top of the Reagan sandstone, SW. ¼ sec. 17, T. 4 N., R. 12 W., about 11 miles (17.7 km.) northwest of Fort Sill, Comanche County, Oklahoma.

Upper? Cambrian: (358a) Siliceous limestone on Ash Creek, in Pinal County, Arizona.

Middle Cambrian: (84 and 84f) "St. Croix sandstone" at Dresbach, opposite the mouth of Black River, Winona County; (339e) "St. Croix sandstone" on Mountain Island, in Mississippi River, just above the mouth of Trempealeau River; and (84s) "St. Croix sandstone" near Dakota, Winona County; all in Minnesota.

(79x) "St. Croix sandstone" near the flour mill on Beaver Creek, north of Galesville; and (328g) "St. Croix sandstone," Wisconsin shore of Mississippi River, near Trempealeau; both in Trempealeau County, Wisconsin.

(167) Sandstone beneath limestone and resting on pre-Cambrian "slates, schists, and pegmatites" in bluff 9 miles (14.4 km.) west of Custer, Black Hills; (355e) sandstone in the central part of the Black Hills; and (355) sandstones in Red Canyon [a] Creek, southwest side of the Black Hills; all in South Dakota.

(11m) Drill cores of limestone in the Bonneterre limestone at horizons 10 and 20 feet (3 and 6 m.) above the Lamotte sandstone, at Flat River, St. Francois County, Missouri.

(329b) Thin-bedded limestone collected by the Wheeler Survey in Utah.

(5k) Limestone in Meagher County, on the road to Wolsey, about 1 mile (1.6 km.) south of the divide at the head of Sawmill Creek, and 8 miles (12.8 km.) south of Neihart, Little Belt Mountains quadrangle (U. S. Geol. Survey), Cascade County; (302k) limestone near Gallatin, Threeforks quadrangle (U. S. Geol. Survey), Gallatin County; (302s) [b] dark siliceous shale in a quarry in Last Chance Gulch, south slope of Mount Helena, 1.5 miles (2.4 km.) south of Helena, Lewis and Clark County; and (340f) lowest beds exposed at the mouth of Bear Creek, Little Belt Mountains; all in Montana.

Dicellomus prolificus Walcott.

Plate LXXXIX, figures 10, 10a–b.

Dicellomus prolificus Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 77, Pl. VIII, figs. 3 and 3a. (Characterized and discussed as below as a new species. Figs. 3 and 3a are copied in this monograph, Pl. LXXXIX, figs. 10 and 10b, respectively.)

This species differs from *Dicellomus politus* (Hall), to which it appears to be most nearly related, by the greater convexity of the ventral valve, its higher umbo, and, in most shells, a greater narrowing toward the apex. The dorsal valve differs from that of *D. politus* in being more rounded on the cardinal margins. It is also to be noted that no traces of muscle scars or vascular markings have been observed on many interiors and casts of the interior of the valves, while in *D. politus* they are prominent on most casts and often on the interior of the valves. The range of outline of the valves of *D. politus* might include those of *D. prolificus*, but the convexity of the ventral valve and the smooth interior seem to distinguish the latter species.

Great numbers of the separated valves occur in several thin layers of gray limestones near the summit of the cliffs on the south side of Marjum Pass.

Formation and locality.—**Middle Cambrian:** (10z) About 2,900 feet (884 m.) above the Lower Cambrian and 1,500 feet (457.2 m.) below the Upper Cambrian in the central part of the limestone forming 1a of the Marjum limestone [Walcott, 1908f, p. 179], in the long cliff about 2 miles (3.2 km.) southeast of Marjum Pass [Walcott, 1908f, Pls. XIII and XV], House Range, Millard County, Utah.

Dicellomus sp. undt. Walcott.

Plate LII, figures 7, 7a.

Dicellomus sp. undt. Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 319. (Mentioned as below as a possible new species.)

A single specimen of a ventral valve very much like that of *Dicellomus appalachia* (Walcott) occurs with material from the *Paradoxides forchhammeri* zone at Andrarum. A series of specimens would probably prove that it is the representative of an undescribed species.

Formation and locality.—**Middle Cambrian:** (3101) *Paradoxides forchhammeri* zone at Andrarum, 20 miles (32.2 km.) northwest of Simrishamn, Province of Christianstad, Sweden.

[a] Some of the specimens are labeled as from Redwater Canyon and some as from Red Canyon Creek, the former locality being given by Whitfield [1882, p. 340].

[b] The specimens from this locality are somewhat doubtfully referred to this species. (See Pl. LII, figs. 4 and 4a.)

Superfamily KUTORGINACEA Walcott and Schuchert.

Family KUTORGINIDÆ Walcott and Schuchert.

Genus KUTORGINA Billings.[a]

Kutorgina Billings, 1861, Geol. Survey Canada, Paleozoic Fossils, vol. 1, p. 9, footnote. (Characterized and discussed as a possible new genus; see below for copy.)

Kutorgina Billings, 1861, Report on the Geology of Vermont, vol. 2, p. 948, footnote. (Copied from preceding reference.)

Kutorgina Billings, 1862, Report on the Economic Geology of Vermont, by Hager, p. 220, footnote. (Copied from preceding reference.)

Kutorgina Billings, Davidson, 1868, Geol. Mag., vol. 5, p. 312. (Merely questions genus.)

Obolella (*Kutorgina*) (Billings), Dall, 1870, Am. Jour. Conchology, 2d ser., vol. 6, pt. 2, pp. 154 and 163. (Described.)

Kutorgina Billings, Davidson, 1871, British Fossil Brachiopoda, vol. 3, pt. 7, No. 4, p. 342. (Copy of Davidson, 1868, p. 312.)

Kutorgina Billings, Dall, 1877, Bull. U. S. Nat. Mus., No. 8, pp. 40–41. (Discussed.)

Kutorgina Billings, Zittel, 1880, Handbuch der Palæontologie, Bd. 1, Abth. 1, p. 664. (Described in German.)

Kutorgina Billings, Walcott (in part), 1886, Bull. U. S. Geol. Survey No. 30, pp. 101–102. (Original characterization, Billings, 1861b, p. 7, copied, and genus described and discussed. The generic description is based on specimens now referred to *Micromitra*, *Micromitra* (*Paterina*), *Micromitra* (*Iphidella*), and *Billingsella*, as well as upon those representing *Kutorgina*.)

? Kutorgina Billings, Oehlert, 1887, Manuel de conchyliologie, by Fischer, p. 1262. (Described in French, with figures of "*Kutorgina cingulata* Linnarsson.")

Kutorgina Billings, Beecher, 1891, Am. Jour. Sci., 3d ser., vol. 41, footnote, pp. 345–346. (Generic relations discussed.)

Kutorgina Billings, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, pp. 247–248. (Described and discussed.)

Kutorgina Billings, Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, pp. 563–564. (Copy of preceding reference.)

Kutorgina Billings, Hall and Clarke (in part), 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 90–94. (Copies Walcott, 1886b, pp. 101–102, on pp. 91–92, and describes and discusses genus, including species now referred to *Micromitra*, *Micromitra* (*Iphidella*), *Micromitra* (*Paterina*), *Protorthis*, and *Billingsella*, as well as those referred to *Kutorgina*.)

Kutorgina Billings, Hall and Clarke, 1892, idem, p. 183. (Discusses generic relations; see the seventh reference in the synonymy of *Botsfordia pulchra*, p. 607.)

Kutorgina Billings, Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 306–308. (Original characterization, Billings, 1861b, p. 7, copied and genus described and discussed essentially as below.)

Kutorgina Billings, Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 209. (Described.)

Kutorgina Billings, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 145. (Classification of genus.)

Billings [1861b, p. 9] proposed the genus *Kutorgina* in a footnote accompanying the description of the type species *K. cingulata*. He says:

> Since the above was written I have examined many casts of the interior of this species, and am inclined to the opinion that it is generically distinct from *Obolella chromatica*. From the very considerable elevation of the beak the dorsal valve must have an area and probably a foramen. In one specimen there are two large oval impressions faintly impressed, but still distinctly visible. There is no trace of the lateral scars, and the form, notwithstanding the characters of the surface, conveys the idea of an *Orthisina*. Should, upon further examination, my suspicions turn out to be well founded, I shall call the genus *Kutorgina*, after the celebrated European naturalist, Kutorga.

From present information of the genus the following diagnosis is prepared:

Shells inequivalve, transverse or elongated. Ventral valve convex, with apex marginal or incurved over the pseudo-area; cardinal area rudimentary, without any delthyrium or well-defined pseudodeltidium; the latter usually extends one-half the distance from the apex to the plane of the posterior margin of the valve; interior of ventral valve with well-defined main vascular sinuses, with a visceral area between the sinuses. Dorsal valve flat or slightly convex, rising to a small, elevated umbo; apex marginal and usually pointing upward; cardinal area

[a] The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Kutorgina* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Lingula Bornemann [1891, p. 439].
Kutorgina Bornemann [1891, p. 440].
Orthis ? Tate [1892, p. 185].
Kutorgina Frech [1897, Pl. I A, figs. 6a–h].
Kutorgina von Toll [1899, p. 26].
Kutorgina Matthew [1899a, p. 189; 1899d, p. 98].
Kutorgina Walcott [1901, p. 695].

short, rudimentary, and without well-defined pseudodeltidium. Interior of ventral valve with median septum between the central and posterolateral muscle scars.

Observations.—The short cardinal areas of the valves leave a broad open space between them for the passage of the pedicle. The areas are more than reflected posterior margins of the valves, as they have transverse lines of growth and a suggestion of a pseudodeltidium. These features are more rudimentary than in *Micromitra*. *Kutorgina* includes the larger calcareous shells, and *Micromitra* the somewhat more specialized, smaller, corneous shells. The exterior form of the valves of *Kutorgina* suggest *Nisusia festinata* (Billings), with which the type species, *K. cingulata* (Billings), is associated in Vermont and at Bic Harbor.

The genus was named in honor of Kutorga.

Kutorgina cingulata (Billings).

Text figures 3, page 299; 8, page 299; 50A–C, page 581; Plate V, figures 1, 1a–s.

Obolella (*Kutorgina*) *cingulata* Billings (in part), 1861, Geol. Survey Canada, Paleozoic Fossils, vol. 1, pp. 8–9, figs. 8 and 10 (not fig. 9). (Described as a new species. Fig. 9 is that of a specimen now referred to *Rustella edsoni*.)

Obolella (*Kutorgina*) *cingulata* Billings (in part), 1861, Report on the Geology of Vermont, vol. 2, p. 948, figs. 347 and 349 (not fig. 348). (Text and figures copied from Billings, 1861b, p. 9, figs. 8 and 10, p. 8. Fig. 348 is that of a specimen now referred to *Rustella edsoni*.)

Obolella (*Kutorgina*) *cingulata* Billings (in part), 1862, Report on the Economic Geology of Vermont, by Hager, p. 220, figs. 347 and 349 (not fig. 348). (Text and figures copied from preceding reference. Fig. 348 is that of a specimen now referred to *Rustella edsoni*.)

Obolella cingulata Billings, 1863, Geol. Survey Canada, Fifteenth Rept. Progress, p. 284, figs. 287a and 287b (not fig. 287c). (No text reference. Figs. 287a and 287b are copied from Billings, 1861b, figs. 8 and 10, p. 8. Fig. 287c represents a specimen now referred to *Rustella edsoni*.)

Kutorgina cingulata (Billings), Walcott (in part), 1886, Bull. U. S. Geol. Survey No. 30, pp. 102–104, Pl. IX, figs. 1, 1a–f (not figs. 1g and 1h). (Original description, Billings, 1861b, p. 9, copied and species described and discussed. The specimens represented by figs. 1, 1a–f are redrawn in this monograph, Pl. V, figs. 1c, 1b, 1d, 1a, 1, 1i, and 1h, respectively. Specimens referred to *Rustella edsoni* are mentioned on p. 103 and are figured, Pl. IX, figs. 1g and 1h.)

Kutorgina cingulata (Billings), Beecher, 1891, Am. Jour. Sci., 3d ser., vol. 41, footnote, pp. 345–346. (Discusses generic relations.)

Kutorgina cingulata (Billings), Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 609, Pl. LXIX, figs. 1, 1a–f (not figs. 1g and 1h). (Mentioned. Figs. 1, 1a–f are copied from Walcott, 1886b, Pl. IX, figs. 1, 1a–f. Figs. 1g and 1h represent specimens now referred to *Rustella edsoni*.)

Kutorgina cingulata (Billings), Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, Pl. IV, figs. 11–13. (No text reference.)

Kutorgina cingulata (Billings), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 92, figs. 47–49; Pl. IV, figs. 10–17. (Mentioned in discussing genus. Figs. 47–49 are copied from Walcott, 1886b, Pl. IX, figs. 1b, 1a, and 1f, respectively. Figs. 13, 14, and 17 are copied from figs. 11–13 of the preceding reference.)

Kutorgina cingulata (Billings), Frech, 1897, Additional plates inserted in 1897 in Lethæa geognostica, pt. 1, Lethæa palæozoica, atlas, 1876, Pl. I A, figs. 6a–b. (No text reference. Figs. 6a–b are copied from Walcott, 1886b, Pl. IX, figs. 1a and 1, respectively.)

Kutorgina cingulata (Billings), von Toll, 1899, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 8, No. 10, pp. 26–27, Pl. I, fig. 28. (Described and discussed in German.)

Kutorgina cingulata Billings, Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 308–309. (Described and discussed essentially as below, with the exception of the notes and figures on the shell structure.)

Kutorgina cingulata von Toll, Walcott, 1905, idem, p. 309. (Species and locality mentioned.)

Kutorgina cingulata (Billings), Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 209, fig. 246. (Described. The three figures of fig. 246 are copied from Walcott, 1886b, Pl. IX, figs. 1, 1a, and 1b.)

General form transversely or longitudinally oval; biconvex, with the ventral much more convex than the dorsal valve. Surface marked by concentric lines and ridges of growth and the edges by imbricating lamellæ of growth. Shell substance calcareous and fibrous. The shell is formed of a thin, dark, compact outer layer and a thick, laminated, calcareous inner layer. It is possible that the thin outer layer is chitinous, but it does not appear to be so.

The L'Anse au Loup and Bic Harbor shells average about 15 mm. long by 17 mm. in width. At the locality near Swanton, Vermont, ventral valves occur 24 mm. in length and 30 mm. in width, and one large dorsal valve is 20 mm. in length with a width of 30 mm.

Ventral valve in young shells moderately convex, becoming more and more convex with increase in size and age; in young shells the slope from the front margin to the apex is nearly straight, and the apex terminates at the posterior edge of the valve above the more or less elevated pseudo-area; in old shells the curvature from the front to the apex is nearly a semicircle, and the apex terminates in a pointed beak overhanging the pseudo-area; a mesial sinus, of varying strength, occurs on many shells, and in others it is entirely absent; the area is concave on the outer parts; toward the center it becomes slightly flattened or convex and thus forms a very rudimentary pseudodeltidium; it extends beneath the apex at an angle of about 45° to the plane of the margins of the valve; the pseudo-area extends about one-half the distance from the apex to the plane of the valve and arches gently from the lateral extremities to the center.

A partly exfoliated shell shows four dark lines radiating forward from the umbo and two near the sides that may have something to do with the muscle scars or vascular sinuses.

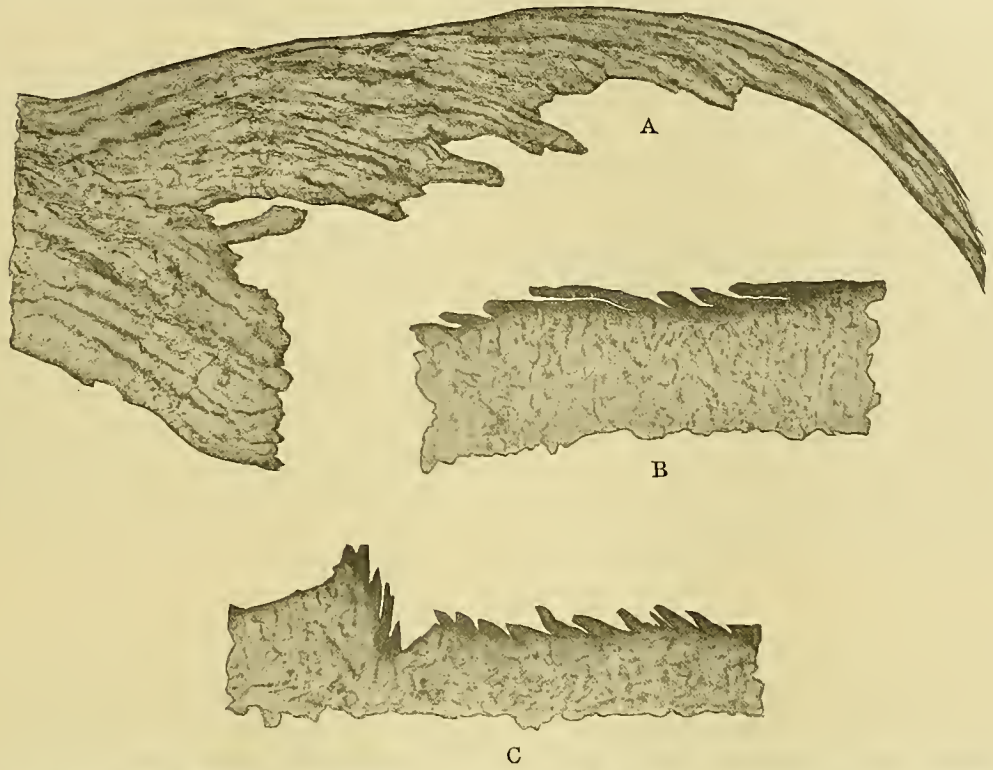


FIGURE 50.—*Kutorgina cingulata* (Billings). A, Enlargement of a portion of a transverse section of an old shell which shows its laminations and the peculiar manner of growth (×30). B, C, Vertical sections of an old shell, showing the imbricated manner of growth of the outer thin dark layer (×30). This outer layer is not preserved in the specimen represented by A.

The specimens from which these sections were made came from Locality **25a**, near Swanton, Vermont (U. S. Nat. Mus. Cat. Nos. 15337f, 15337g, and 15337h, respectively).

I thought so in 1886 [1886b, p. 103] but am not sufficiently confident of it now to state it as a settled conclusion. Fine punctæ occur on the inner layer of the shell; also numerous radiating lines about one-half millimeter apart.

Dorsal valve gently convex in young shells; with increase in size the umbo becomes more elevated and the apex points upward or terminates at the union of the pseudo-area and the upward slope of the shell on the umbo; in some shells there is a tendency for the valve to become slightly concave in the space between the margins and the elevated umbo; the area of the valve is narrow and with little character; on some shells it slopes beneath the apex, and on others it slopes backward forming a low angle with the surface of the valve; the interior of the dorsal valve shows a median septum with two central scars (h) and the anterolateral scars (j) (Pl. V, fig. 1h); numerous small vascular canals radiate from the central concave area toward the flattened anterior and lateral half of the valve; a cast of the interior (Pl. V,

fig. 1d) shows two vascular canals radiating forward from near the apex. Radiating lines occur on the interior of the same character as those of the ventral valve.

Observations.—Since writing on this species in 1886 I have collected specimens showing the character of the areas of the valves and also obtained further information relative to the interior of the dorsal valve. The rudimentary areas are less advanced in development than those of *Micromitra*, and the muscle scars of the dorsal valve are much like those of *Obolella* and *Obolus*.

The presence of rudimentary teeth in *Kutorgina cingulata* is very difficult to demonstrate by actual observation, owing to the character of the matrix in which the specimens occur. That articulating processes are present, however, is indicated by the fact that in a relatively small collection thirty of the valves are united, and the fact that the dorsal valve is rarely in any other position than that in which it would be if teeth in the ventral valve held it in its normal position. In only a few of the specimens have the valves slid or turned either way, as they frequently do in the inarticulates.

The specimens from Bic Harbor and east of Swanton, Vermont, are better than those from the type locality at L'Anse au Loup, so I have selected material from these localities for illustration, with the exception of a dorsal and ventral valve. Many of the Vermont shells are larger and more fully developed, but specimens of the same size as those from L'Anse au Loup and Bic Harbor are identical in the characters available for comparison.

FORMATION AND LOCALITY.—**Lower Cambrian:** (**392a**) *Limestones at L'Anse au Loup, on the north shore of the Straits of Belleisle;* and (**3921**)[a] arenaceous limestone at Point Amour, Straits of Belleisle; both in Labrador.

(**2o**) Limestone bowlders in conglomerate, on shore at east entrance to harbor at Bic, Rimouski County, Quebec, Canada.

(**25a**)[b] Limestone on the Hall (Donaldson's) farm, 2 miles (3.2 km.) east of Swanton; and (**319m**) shales of No. 6 of the section at Parker's quarry [Walcott, 1891b, p. 278], near Georgia; both in Franklin County, Vermont.

(**1v**) Shales of No. 3 of the Silver Peak Group, Barrel Spring section [Walcott, 1908f, p. 189], 3 miles (4.8 km.) north of Valcalda Spring and 4 miles (6.4 km.) west-northwest of the Drinkwater mine, Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County, Nevada.

(**35f**) About 300 feet (91 m.) below the Middle Cambrian in the limestone forming 6 of the Mount Whyte formation [Walcott, 1908c, p. 242 (11)] just above the tunnel on the north shoulder of Mount Stephen, about 3 miles (4.8 km.) east of Field, British Columbia, Canada.

(**347** [von Toll, 1899, p. 27]) Near Tschurskaja Station, on Lena River, Siberia.

KUTORGINA GRANULATA Matthew.

Plate V, figures 5, 5a–c.

Kutorgina granulata MATTHEW, 1899, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 3, No. 18, p. 189, Pl. I, figs. 2a–d. (Characterized and discussed as a new species. The specimens represented by figs. 2a, 2b, and 2c are redrawn in this monograph, Pl. V, figs. 5 and 5a, 5c, and 5b, respectively.)

Kutorgina granulata MATTHEW, 1899, Trans. Roy. Soc. Canada for 1899, 2d ser., vol. 5, sec. 4, No. 4, p. 98, Pl. V, figs. 2a–d. (Described and discussed. Figs. 2a–d are copied from figs. 2a–d of the preceding reference.)

The description by Matthew [1899e, p. 98] follows:

Shell substance calcareous. Hinge-line straight, somewhat shorter than the full width of the shell; lateral margin straight near the hinge; front margin broadly rounded.

Ventral valve convex, the umbo considerably elevated, the posterior third of the shell somewhat more tumid than the rest; lateral angles somewhat flattened. The area appears to have a deltidium, about one-fifth as wide as the length of the hinge-line; this line, when viewed from behind, appears to be bent up in the middle. *Interior:* On the posterior half there are a number of low vascular ridges; two of these inclose a median groove, which extends to within a third of the front of the valve; there are about three other ridges on each side. These ridges are most distinct near the umbo, and about three or four are found in the space of 1 millimeter.

The dorsal valve is flatter, and has the umbo depressed to the cardinal line, and the sides of the valve toward the hinge much flattened. *Interior:* There is a median septum extending about one-third of the length of the valve, and faintly indicated for another third to a point where there is a small pit on the inner surface of the valve; and there are also radiating lines as in the ventral valve, but more numerous.

The surface is minutely granulated. On the somewhat tumid posterior third of the valve concentric striæ are faintly visible, but they become distinct on the anterior part, and there are very fine radial lines, giving to the summit

[a] These specimens are in the collections of the Geological Survey of Canada. [b] The species also occurs in Locality **319e**.

of the intervening ridgelets a beaded appearance; at certain intervals stronger concentric striæ of growth show on the surface of the shell; there are about five or six of these on its surface.

Length, 4 mm.; width, 6 mm.; depth of the ventral valve, 1.5 mm.

This species is smaller than *K. cingulata* and differs in its ornamentation.

Observations.—This little shell occurs in reddish limestone beneath a shaly band in which I found fragments of *Olenellus*. Except for size it is much like *Kutorgina cingulata* (Billings) in its general aspect. It differs in the details of surface ornamentation and interior radiating lines.

The form owes its specific name to its granulated surface.

Formation and locality.—**Lower Cambrian**: (**314b** [Matthew, 1899e, p. 97]) Limestone of the "Etcheminian series," at Smith Sound, Trinity Bay, Newfoundland.

Kutorgina peculiaris (Tate).

Plate V, figure 2.

Orthis (?) peculiaris Tate, 1892, Trans. Roy. Soc. South Australia for 1892, vol. 15, pt. 2, pp. 185–186, Pl. II, fig. 5. (Described as a new species; see below for copy. The specimen represented by fig. 5 is redrawn in this monograph, Pl. V, fig. 2.)

The original description by Tate follows:

Transversely subquadrilateral, equilateral; hinge-line in the longest anteroposterior [transverse] diameter, straight.

Ventral (?) valve flatly convex, with an abruptly depressed and deeply bilobed ventral margin; the mesial furrow decreases in depth as it ascends to near the umbo; the lateral margins are obliquely arched, nearly straight, forming an angle of about 70° with the hinge-line.

Surface marked by depressed unequal folds of growth.

The author [1892, p. 185] referred to the valve as ventral (?). Its reference to *Kutorgina* identifies the valve as the dorsal. I do not know of a closely related form.

The form owes its specific name to the fact that it seemed to be an unusual representative of the genus to which it was first assigned.

Formation and locality.—**Middle? Cambrian**: (**315a**) *Limestone at Parara, near Ardrossan;* and (**315**) limestone at Curramulka; both [Tate, 1892, p. 185] in Yorke Peninsula, South Australia.

Kutorgina perugata Walcott.

Plate V, figures 3, 3a–e.

Kutorgina perugata Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 310. (Described and discussed essentially as below as a new species.)

General form ovate, biconvex. Surface marked by concentric lines of growth and more or less strong concentric corrugations. The outer surface is ornamented by a fine network of oblique depressed lines that leave minute rhomboidal elevations between them that look like fine papillæ under a moderately strong magnifier, and the cast of the surface has much the same appearance in a transverse light. Shell substance calcareous.

A large ventral valve has a length of 14 mm., width 16 mm. A dorsal valve 11 mm. in length has a width of 14 mm.

The ventral valve is strongly convex in adult shells, with the highest point near the umbo or at the apex; the apex terminates at or overhangs a rudimentary pseudo-area that slopes beneath the shell at an angle of 45° to 60° to the plane of the margins of the valve; the pseudo-area is concave and about half the length of the space between the apex and the plane of the valve. Casts of the interior show well defined main vascular sinuses, with the outline of the visceral area between them.

The dorsal valve is transverse, nearly flat in some examples and slightly convex in others. The surface slopes gradually from the margins to near the umbo, where the slope increases and extends to the upward-pointing apex; a rudimentary pseudo-area slopes backward from the apex. In some examples the pseudo-area appears to be little more than a bending over

of the posterior margins of the shell; in others it has the outline of a slightly convex pseudo-deltidium.

Observations.—This species in its reticulate surface ornamentation recalls *Micromitra (Iphidella) pannula* (White) and *Mickwitzia monilifera* (Linnarsson). In form the young shells are not unlike *Kutorgina cingulata* (Billings). A large, imperfect, ventral valve, 24 by 24 mm., of this genus, was collected by J. E. Clayton from the Cambrian limestone of the Silver Peak district. It may belong to *K. perugata*, and it is so referred for the present. From the shales of the *Olenellus* zone in Silver Canyon, White Mountain Range, a series of compressed specimens was collected. Some of these show a concave pseudo-area on the ventral valve, also strong main vascular sinuses. Some of the shells from the shales of Locality 175 have lost all traces of surface characters, only a faint, smooth impression remaining.

Formation and locality.—**Lower Cambrian:** (313i) Limestone collected at long. 117° 20′ W., lat. 38° N., in the western part of Esmeralda County, Nevada.

(1v) *Shales of No. 3 of the Silver Peak group, Barrel Spring section [Walcott, 1908f, p. 189], 3 miles (4.8 km.) north of Valcalda Spring and 4 miles (6.4 km.) west-northwest of the Drinkwater mine;* (175)[a] shales carrying *Olenellus* on the divide between Clayton and Fish Lake valleys, about 15 miles (24.2 km.) south-southwest of the town of Silver Peak; and (184) shales at the summit of the Silver Peak Range, 10 miles (16.1 km.) southwest of the town of Silver Peak; all in the Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County, Nevada.

(7) Shaly beds about 1,000 feet (305 m.) above the quartzitic beds, Silver Canyon, White Mountain Range, Inyo County, California.

Kutorgina sardiniaensis Walcott.

Plate V, figures 4, 4a–c.

Kutorgina cingulata Bornemann [not (Billings)], 1891, Nova Acta Acad. Cæs. Leop.-Carol. Germanicæ Natnræ Curiosorum, Bd. 56, No. 3, p. 440, Pl. XIX (XXXIV), figs. 22 and 23. (Described and discussed in German; see below for translation. Figs. 22 and 23 are copied in this monograph, Pl. V, figs. 4b and 4c, respectively.)

Lingula rouaulti Bornemann [not Salter], 1891, idem, p. 439, Pl. XIX (XXXIV), fig. 21. (Characterized and discussed in German. Fig. 21 is copied in this monograph, Pl. V, fig. 4.)

Kutorgina sardiniaensis Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 695. (Merely changes specific reference of Bornemann's *Kutorgina cingulata.*)

Kutorgina sardiniaensis Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 311. (Original description, Bornemann, 1891, p. 440, translated as below and species discussed as below as a new species.)

The original description by Bornemann follows:

Transversely oval, more or less arched, with a straight margin which is a little shorter than the greatest breadth of the shell. Surface shows strong concentric lines of growth.

Found quite commonly in the slates with *Olenopsis* and *Metadoxides* near Canal Grande, and rarely in sandstone with *Archæocyathus* on Punta Pintau. The specimens in the argillaceous shale are always pressed very flat, and are imperfect; in the sandstone, impressions of the outer surface are often found.

Here belongs, perhaps, also the shell designated above as *Lingula rouaulti* (?).

All that is known of the species is represented by the illustrations. It appears to be congeneric with *Kutorgina cingulata* (Billings), but not specifically identical with it.

Formation and locality.—**Middle? Cambrian:** (354) *Yellowish-brown slates not far from the buildings of Canal Grande;* (354b) yellowish sandstone with *Archæocyathus* at Punta Pintau and elsewhere; and (354e)[b] slate at Porto Canal Grande; all [Bornemann, 1891, pp. 439 and 440] in the island of Sardinia, Italy.

Kutorgina sp. undt. Walcott.

Kutorgina sp. undt. Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 311. (Characterized and discussed as below as an undetermined species.)

Ventral valve transverse, moderately convex; length, 6 mm.; width, 8 mm.; pseudo-area short and sloping beneath the apex at an angle of about 45°.

A single cast from a coarse sandstone is all that is known of this species. It may be a young shell of *K. cingulata* (Billings), but the means of comparison do not justify such a reference.

Formation and locality.—**Lower Cambrian:** (47a) Sandstone on the southwest side of Sallings Mountain, 2 miles (3.2 km.) east of Natural Bridge, Rockbridge County, Virginia.

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[a] The species is somewhat doubtfully identified from this locality.

[b] Specimens from this locality are in the collections of the United States National Museum.

Family SCHUCHERTINIDÆ Walcott.

Genus SCHUCHERTINA Walcott.

Schuchertina WALCOTT, 1905, Proc. U. S. Nat. Mns., vol. 28, p. 323. (Mentioned as below as a new genus.)
Schuchertina WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 145. (Classification of genus.)

The description of the type species includes that of the genus, as but one species is known.

Type.—*Schuchertina cambria* Walcott.

The generic name is given in recognition of the thorough work that Prof. Charles Schuchert has done on the Brachiopoda.

SCHUCHERTINA CAMBRIA Walcott.

Plate LI, figures 6, 6a–m.

Schuchertina cambria WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 323-324. (Described and discussed as below as a new species.)

Shell subovate, with valves obtusely acuminate, biconvex. Surface marked by concentric lines and striæ of growth and fine radiating striæ. The inner and outer surface of the shells have very fine punctæ, but no traces of punctæ penetrating through the shell have been observed.

The largest ventral valve has a length of 22 mm.; width, 23 mm.; dorsal valve, length, 17 mm.; width, 18 mm. Shell substance calcareous, rather thick on the umbonal region and thin toward the margins.

Ventral valve subacuminate, moderately convex; on some of the larger shells a broad mesial fold and arching of the frontal margins are present; apex terminates at the margin above a triangular opening or delthyrium; area small and within the plane of the margins of the valve; it is attached to the bottom of the valve and divided midway by a very slight pedicle groove; the margins of the delthyrium-like opening sustain an angle of about 45° to the plane of the valve, and the solid area within is at its center nearly on the plane of the valve; the anterior margins of the area extend upward to meet the margins of the shell, thus forming a solid arched area. The interior of the valve is marked by radiating, shallow, narrow furrows that vary in number and strength in different shells; just in front of the area on each side of the median line oval depressions occur, which correspond in position and shape to the diductor muscle scars of the ventral valve of the Billingsellidæ, and they are so interpreted on the figures; traces of the adductor scars are found on each side of the median line. Dorsal valve obtusely acuminate, about as convex as the ventral valve; apex marginal on the broad, low, median arch of the posterior margin; the only trace of an area that has been observed is shown on figure 6j; a broad, shallow mesial sinus and projecting front margin occur on adult shells; the position of the anterior and posterior adductor muscle scars is indicated, also the umbonal thickening in which the diductor muscles were probably attached, as there is no trace of a cardinal process; radiating furrows like those in the ventral valve are strongly marked in adult shells.

Observations.—*Schuchertina cambria* is a shell that, as far as I know, is unique. In its exterior form it suggests a biconvex orthoid genus, and this likeness is further increased by the flabelliform scars of the ventral valve; the smooth surface and solid cardinal areas suggest *Elkania*. It may be that *Schuchertina* is a type derived from some early Cambrian form allied to the Billingsellidæ. Its general aspects appear to affiliate it with the Orthidæ.

FORMATION AND LOCALITY.—**Middle Cambrian**: (5k) Limestone in Meagher County on the road to Wolsey, about 1 mile (1.6 km.) south of the divide at the head of Sawmill Creek, and 8 miles (12.8 km.) south of Neihart, Little Belt Mountains quadrangle (U. S. Geol. Survey), Cascade County, Montana.

Order NEOTREMATA Beecher.

[νέος, young; and τρῆμα, perforation.]

Superfamily SIPHONOTRETACEA Walcott and Schuchert.

Family OBOLELLIDÆ Walcott and Schuchert.

Genus OBOLELLA Billings.[a]

[Obolus.]

Obolella Billings, 1861, Geol. Survey Canada, Paleozoic Fossils, vol. 1, p. 7. (Described and discussed as a new genus.)

Obolella Billings, 1861, Report on the Geology of Vermont, vol. 2, p. 946. (Copy of preceding reference.)

Obolella Billings, 1862, Report on the Economic Geology of Vermont, by Hager, p. 218. (Copy of preceding reference.)

Obolella Billings, 1862, Am. Jour. Sci., 2d ser., vol. 33, pp. 420–421. (Note on date of first publication.)

Obolella Billings, Hall, 1863, Sixteenth Ann. Rept. New York State Cab. Nat. Hist., p. 131. (Original description, Billings, 1861b, p. 7, copied.)

Obolella Billings, Meek and Hayden, 1865, Smithsonian Contrib. Knowl., No. 172, Paleontology Upper Missouri, pt. 1, pp. 3–4. (Original description, Billings, 1861b, p. 7, copied.)

Obolella Billings, Davidson, 1866, British Fossil Brachiopoda, vol. 3, pt. 7, No. 1, p. 60. (Original description, Billiugs, 1861b, p. 7, copied and genus discussed.)

Obolella Billings, Hall, 1867, Trans. Albany Inst., vol. 5, p. 108. (Original description, Billings, 1861b, p. 7, copied.)

Obolella Billings, Davidson, 1868, Geol. Mag., vol. 5, pp. 308–309. (Original description, Billings, 1861b, p. 7, copied and genus discussed.)

Obolella Billings, Dall, 1870, Am. Jour. Conchology, 2d ser., vol. 6, pt. 2, pp. 154 and 163. (Described.)

Obolella Billings, Davidson, 1871, British Fossil Brachiopoda, vol. 3, pt. 7, No. 4, pp. 338–339. (Copied from Davidson, 1868, pp. 308–309.)

Obolella Billings, 1872, Canadian Naturalist, 2d ser., vol. 6, No. 2, pp. 217–218. (Described and discussed.)

Obolella Billings, 1872, Am. Jour. Sci., 3d ser., vol. 3, pp. 355–357. (Described and discussed.)

Obolella Billings, 1876, idem, vol. 11, pp. 176–178. (General description and discussion of genus and species referred to it.)

Obolella Billings, Zittel, 1880, Handbuch der Palæontologie, Bd. I, Abth. 1, p. 664. (Described in German.)

Obolella Billings, Ford, 1881, Am. Jour. Sci., 3d ser., vol. 21, pp. 131–134. (General discussion of genus and species referred to it.)

Obolella Billings?, Walcott, 1884, Mon. U. S. Geol. Survey, vol. 8, pp. 67–68. (Genus discussed in description of "*Obolella ambigua.*")

Obolella Billings, Walcott, 1886, Bull. U. S. Geol. Survey No. 30, pp. 109–112. (Original description, Billings, 1861b, p. 7, and later description, Billings, 1876, p. 176, copied and species referred to the genus discussed.)

Obolella Billings, Oehlert, 1887, Manuel de conchyliologie, by Fischer, p. 1262. (Described in French, with figures of "*O. desquamata* Hall.")

Obolella Billings, Hall and Clarke (in part), 1892, Eleventh Ann. Rept. State Geologist New York for 1891, pp. 240–241. (Described and discussed, the genus *Dicellomus* being included as a synonym.)

Obolella Billings, Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, pp. 556–557. (Copy of preceding reference.)

Obolella Billings, Hall and Clarke (in part), 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 66–73. (Genus described, with a general discussion of the genus and the species referred to it. The genus *Dicellomus* is included as a synonym, and the reference also includes species now referred to *Bicia*, *Obolus*, etc.)

Obolella Billings, Hall and Clarke, 1892, idem, pp. 164–165. (Generic relations discussed.)

Obolella Billings, Matthew, 1892, Trans. Roy. Soc. Canada for 1891, vol. 9, sec. 4, No. 5, pp. 39–40. (Original description, Billings, 1861b, p. 7, copied and literature on the genus discussed.)

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[a] Many of the references to *Obolella* in the synonymy are based upon or include species now referred to other genera. The present reference of all species formerly placed under *Obolella* will be found on pages 69–72. The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Obolella* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Orbicula? Hall [1847, p. 290].
Avicula? Hall [1847, p. 292].
Obolella? (*Orbicula?*) Ford [1871, p. 33].
Dicellomus Hall [1873, p. 246].
Obolella Ford [1878, p. 128].
Obolella Walcott [1885a, pp. 115–117; 1885b, p. 21].
Obolella Ford [1886a, p. 466].
Obolella Shaler and Foerste [1888, p. 27].
Obolella Walcott [1890b, p. 36].
Camerella Walcott [1890b, p. 36].
Obolella Walcott [1891a, p. 611].
Camarella Walcott [1891a, p. 614].
Camarella Hall and Clarke [1894, p. 221].
Protorhyncha? Schuchert [1897, p. 334].
Obolella Matthew [1899d, p. 70].
Obolella Walcott [1899, p. 446].
Obolella Burr [1900, p. 47].
Obolella Grabau [1900, p. 620].
Obolella Walcott [1901, p. 674].
Obolella? Matley [1902, pp. 137 and 139].
Obolella Delgado [1904, p. 364].
Obolella Etheridge [1905, pp. 248 and 249].
Obolella Gorham [1905, Pl. I].
Obolella Walcott [1905a, pp. 297 and 313].
Obolella Clark and Mathews [1906, p. 252].

Obolella Billings, Mickwitz, 1896, Mém. Acad. imp. sci. St.-Pétersbourg, 8th ser., vol. 4, No. 2, pp. 116, 121, and 123–126. (Copies the description of the genus as given by Hall aud Clarke, 1892c, pp. 66–67, on pp. 123 and 124 and gives a general discussion of the generic relations of *Obolella* and *Obolus*, etc.)

Obolella Billings, Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 188. (Described.)

Obolella Billings, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 145. (Classification of genus.)

Generic characters.—Shell subequivalve, moderately convex; dorsal valve more elevated at the umbo than the ventral; longitudinally ovate or oval in outline, with the dorsal valve sometimes transversely oval. Surface marked by concentric striæ of growth and radiating striæ, except in the subgenus *Glyptias*, which has irregular transverse lines crossing the concentric striæ.

Shell substance unknown in an unaltered condition; it is now calcareous but it may have been calcareocorneous as in *Obolus*. Shell structure formed of a thin outer layer with many thin inner layers or lamellæ more or less oblique to the outer layer; the short lamellæ of the anterior portion of the valves are more oblique than the longer lamellæ of the central and posterior portions and lie at the edges in the same plane as the margins of the valves.

Area of the ventral valve rises from the plane of the margins of the valve at angles varying from 10° to 70°; broadly subtriangular when the beak is projecting, otherwise rounded at the posterior margin almost as much as the area of the dorsal valve; the latter is usually on the plane of the margins of the valve and broadly rounded posteriorly; both areas are striated parallel to the base; in the ventral valve a narrow, shallow furrow divides the area midway; the area of the dorsal valve is divided by a narrow, raised, triangular space, bordered on either side by a more or less deeply impressed groove formed by a narrow fold of the area lamellæ; outside of this groove, and between it and the outer flexure fold of the area (f), a depressed triangular space occurs that has led authors to consider it as the scar of the point of attachment of cardinal muscles (Pl. LIV, figs. 1h, 1i). It sometimes occurs that the inner angle of the area of the ventral valve adjoining the pedicle opening projects forward so as to form a toothlike knob that in the cast is shown by a deep indentation beside the cast of the pedicle opening and between the latter and the projecting cast of the undercut beneath the area (Pl. LV, figs. 1f, 1g). Pedicle opening or foramen of the ventral valve cylindroconical, broad at the base and tapering to a minute apex; position of the external opening a little in advance of the point of the beak; as indicated by casts of the tube in *O. atlantica* and a specimen of *O. crassa*. The opening varies in proportional size in different species; it is usually marked by rather strong striæ of growth. It extends upward and backward through the shell, very much as does the foramen in *Trematobolus* and *Botsfordia*.

Splanchnocœle [a] of the ventral valve confined to the posterior half of the valve while in the dorsal valve it extends forward to and in some instances beyond the center; in both valves it extends back to the central part of the area which is bounded by the flexure lines (Pl. LIV, figs. 1i, 2g, 2m). Traces of a median septum are shown in the dorsal valve (Pl. LIV, figs. 1h, 1i, and Pl. LV, fig. 1i), but no definite septum has been observed in the ventral valve. A central median ridge of varying degrees of size and length often extends toward the central portion of the dorsal valve; when it is large, a deep rounded groove usually occurs on each side of it on the inner slope of which the central muscle scars may be situated (Pl. LIV, figs. 2k–m). Often the median ridge is practically absent (Pl. LV, figs. 1i, 4a).

The grooves of the main vascular sinuses begin in each valve at the front margin of the area near the median line, and in the ventral valve gradually extend forward and outward toward the front half of the shell where they begin gently to curve inward, terminating toward the front of the valve, the distance and curvature varying in different species (Pl. LIV, figs. 1f, 2g, 2h, and Pl. LV, figs. 1f, 1h, 3c); in the dorsal valve the main vascular sinuses curve out more rapidly (Pl. LIV, figs. 1i, 2m) and are much less prominent; none of the secondary radial canals or the peripheral vascular sinuses have been observed. The course of the parietal scar between the main vascular sinuses is in front of the splanchnocœle in the ventral

[a] Using nomenclature of Mickwitz, 1896.

valves (Pl. LIV, figs. 1e, 2g, 2h), also in the same valves it passes closely around the muscle scars situated between the main sinuses and reaches the base of the area in line with the flexure line of the area; in the dorsal valve it closely follows the outside limits of the muscle scars, but it has not been traced across the main vascular sinuses.

The size and position of the pedicle and umbonal muscle scars is unknown, but they are probably similar to those of *Obolus*. The central scars (h) (Pl. LIV, figs. 1h, 2k, 2 l) are placed a little distance each side of the median line in the dorsal valve; in the ventral valve they are not separable from the middle and outside laterals, which occur on each side of the front of the visceral area at (c) (Pl. LIV, fig. 2h). The middle and outside laterals of the dorsal valve (l) are blended and lie obliquely outward before the transmedian scars (i). The transmedian scars are close to the base of the area in both valves, and lie in the line of the prolongation of the flexure line of the area. In number and relative position the muscle scars of *Obolella* as far as known are essentially the same as in *Obolus*.

Observations.—The genus *Obolella* has been under discussion by authors for over fifty years. In the original description Billings [1861b, p. 7] noted its resemblance to *Obolus* but claimed that it was distinct on account of the difference in "the arrangement of the muscular impressions." Later [1872c, p. 356] he compared it again with *Obolus*, but having poor illustrations of both *Obolus* and *Obolella* he failed to discover the true position and relations of the muscle scars in either. It was not until after Mickwitz's memoir [1896] on *Obolus* appeared, and the collections of *Obolella* made under my direction during the summer of 1899 were studied, that any correct comparisons could be made. It then became evident that as far as known there was practically no difference in the arrangement of the muscle scars of the two genera, but that there were most essential differences in the cardinal area of the ventral valve. Before working out the fact that the ventral valve was perforated by a pedicle tube or foramen, I was at a loss to find generic difference of value, although I believed that the area of the dorsal valve of *Obolella* indicated differences not readily explained.

The pedicle passage of *Obolus* varies greatly in size and form, but it is always an open furrow. In *Obolella*, it is in the ventral valve a cylindroconical tube, the cardinal area rising from the plane of the margin of the valve beneath the pedicle tube; in the dorsal valve a slightly raised area occupies the place of the broad furrow in *Obolus*.

Obolella is confined to the *Olenellus* or Lower Cambrian fauna. *Obolus*, as now limited, appears in the Lower Cambrian, and has its greatest development in the Middle and Upper Cambrian fauna.

Bicia gemma is associated with *Obolella crassa* both at Bic and Troy, and the species was referred to *Obolella* by Billings [1872a, p. 218]. It differs so radically from *Obolella* in the character of the areas of the valves and the interior markings that it is scarcely necessary to institute comparisons between them. *Lingulella schucherti* is found associated with *Obolella crassa* at Troy, New York.

The interior markings of *Obolella* and *Botsfordia* are quite similar (Pls. LIV and LV, and Pls. LVII and LIX). The same is true of *Trematobolus* (Pl. LXXXIII), but the pedicle opening of *Botsfordia* is above the beak with almost no area beneath, while that of *Obolella* is above a well-defined false area, and that of *Trematobolus* is more in advance of the beak.

Obolella asiatica Walcott.

Plate LV, figures 6, 6a.

Obolella asiatica Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 297. (Described and discussed as below as a new species.)

General form broad, ovai, with the ventral valve showing a tendency to become bluntly acuminate. Valves gently convex. Surface of shell marked by concentric, raised lines of growth that form the front edge of narrow lamellæ of varying width; the raised lines are highest in front, which gives an imbricated appearance to the surface; fine concentric striæ occur on the interspaces between the raised lines. Shell strong, apparently calcareous.

The specimens occur in a compact, bluish-gray oolitic limestone. None of them show the area or interior of the valves. The reference to *Obolella* is based on the general form and calcareous shell. The shells vary in size from 3 to 5 mm.

Obolella asiatica may be compared with young shells of *O. crassa*. Its broadly elliptical form and slight convexity distinguish it from other species of the genus.

It may be that if material is found showing the interior valves the generic reference will be changed; but with the data now available, the reference is to *Obolella*.

The geological horizon is in some doubt, as the specimens were found in a block of river drift limestone. The associated fragments of trilobites are too indefinite for determination. *Obolella* is a Lower Cambrian genus as far as known, and other blocks of river drift limestone at the same locality contained fragments of *Redlichia*, so the reference of the species is made to the Lower Cambrian. By error *O. asiatica* was included in the list of the Middle Cambrian fossils of China [Walcott, 1905b, p. 5].

FORMATION AND LOCALITY.—**Lower Cambrian**: (**C32′**) *Limestone bowlder collected in river drift 1 mile (1.6 km.) south of Chonpinghien, on Nankiang River, southern Shensi;* and (**C17**) ferruginous limestone nodules in the brown sandy shales at the top of the Manto shale [Blackwelder, 1907a, p. 27 (list of fossils at top of page) and fig. 6 (bed 15), p. 25], at Changhia, Shantung; both in China.

OBOLELLA ATLANTICA Walcott.

Text figure 51, page 590; Plate LV, figures 1, 1a–i.

Obolella crassa SHALER and FOERSTE [not (HALL)], 1888, Bull. Mus. Comp. Zool. Harvard Coll., whole ser. 16, No. 2 (geol. ser. 2), p. 27, Pl. I, figs. 1a–f. (Described.)

Obolella sp. SHALER and FOERSTE, 1888, idem, pp. 27–28, Pl. I, figs. 2a–c. (Described.)

Obolella atlantica WALCOTT, 1890, Proc. U. S. Nat. Mus. for 1889, vol. 12, p. 36. (Characterized.)

Obolella atlantica WALCOTT, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 611, Pl. LXXI, figs. 1, 1a–c. (Copies Walcott, 1890, p. 36. Figs. 1 and 1b are copied in this monograph, Pl. LV, figs. 1b and 1c, respectively. Figs. 1a and 1c were slightly altered before they were used in this monograph, Pl. LV, figs. 1i and 1h, respectively.)

Obolella atlantica Walcott, MATTHEW, 1899, Trans. Roy. Soc. Canada for 1899, 2d ser., vol. 5, sec. 4, No. 3, p. 70. (Copies Walcott, 1890, p. 36, and discusses species.)

Obolella atlantica Walcott, BURR, 1900, American Geologist, vol. 25, p. 47. (Discussed.)

Obolella atlantica Walcott, GRABAU, 1900, Occas. Papers, Boston Soc. Nat. Hist., No. 4, vol. 1, pt. 3, pp. 620–621, Pl. XXXIV, figs. 3a–b. (Described.)

Obolella crassa Shaler and Foerste, GORHAM [not (HALL)], 1905, Bull. Roger Williams Park Museum, No. 9, Pl. I, figs. 1a–f. (No text reference. Figs. 1a–f are copied from Shaler and Foerste, 1888, Pl. I, figs. 1a–f.)

Obolella atlantica Walcott, GORHAM, 1905, idem, Pl. I, figs. 2a–c. (No text reference. Figs. 2a–c are copied from Shaler and Foerste, 1888, Pl. I, figs. 2a–c, respectively.)

Obolella atlantica Walcott, GRABAU and SHIMER, 1907, North American Index Fossils, vol. 1, p. 188, figs. 222a–d. (Described. Figs. 222a–d are copied from Walcott, 1891a, Pl. LXXI, figs. 1, 1a–c, respectively.)

General form ovate, with ventral valve obtusely acuminate in the uncompressed specimens; dorsal valve nearly circular, with the transverse diameter the greatest in the best preserved shells (Pl. LV, figs. 1h and 1i). Valves moderately convex. Surface of the shell marked by concentric striæ and more or less imbricating lines of growth; fine radiating striæ that are sometimes raised lines strongly mark most shells, although in some instances the striæ are absent, probably from having been worn away by abrasion. When the imbricating lamellæ of the shell are broken the surface has the appearance shown by figure 1c.

The shells from the limestones of Manuels Brook appear to be relatively thick and formed of several layers, the lamellæ being arranged so as to terminate slightly oblique to the outer surface, thus forming the foundation for the imbricating lines of growth. The Smith Point material shows only casts of the outer and inner surfaces, as do most of the specimens from North Attleboro. The thickening of the outer portions of the shell by the growth of the oblique lamellæ forms a strong interior margin which is usually flat (Pl. LV, figs. 1a and 1h), but it is sometimes oblique to the plane of the edges of the valves (fig. 1a). The ventral valves average about 5 mm. in length, the largest is 8 mm.; the dorsal valve is a little shorter than the ventral.

The area of the ventral valve is low and rises from the edge of the valve to meet the beak at an angle of 30° to 45°; it extends well out on the cardinal slopes before merging into them; a narrow furrow divides it midway.

The anterior margin of the area adjoining the false pedicle furrow forms a tooth or knob-like projection (Pl. LV, fig. 1e) that forms a deep recess next to the cast of the pedicle tube in the casts of the interior of the ventral valve (fig. 1f). The surface of the area is marked by fine transverse striæ. On each side of the pedicle tube there is a strong undercut which in the cast is replaced by a toothlike projection. The area of the dorsal valve extends nearly as far out on the cardinal slopes as that of the ventral; it is marked midway in the cast by two ridges that converge toward the median line at the posterior margin; these ridges represent furrows such as occur on the areas of some species of *Obolus* and *Lingulella* at the side of the flexure lines (*Lingulella acutangula* (Roemer), Pl. XVII, fig. 1h). They are also present in the dorsal valve of *Obolella chromatica* Billings.

The pedicle tube or foramen is beautifully shown in numerous casts of the ventral valve. When the shells are compressed the cast of the tube rests so nearly on the area that one is led to doubt the existence of shell between the area and the tube. (See Pl. LV, figs. 1f, 1g, 3c.) In uncompressed specimens the cast of the tube extends upward and backward as shown by figure 1h. The cast shows a minute apex and trumpet-shaped base. None of the specimens show the exterior foraminal opening, nor has it been seen in any species of the genus.

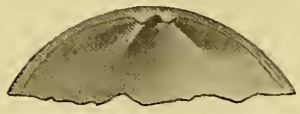

FIGURE 51.—*Obolella atlantica* Walcott. View of ventral valve, tipped back to show pedicle opening beneath the area (× 4). (The same specimen is shown in a different position in Pl. LV, fig. 1e.) The specimen is from Locality 5o, Lower Cambrian shales at Smith Sound, Trinity Bay, Newfoundland (U. S. Nat. Mus. Cat. No. 51948a).

The strong pedicle furrow shown on the cardinal area in Plate LV, figure 1e, does not exist on the specimen, except as indicated by two faint lines. The true pedicle tube opening is shown beneath the area, as represented in figure 51. This was drawn from the same specimen as that represented in Plate LV, figure 1e.

The muscle scars are not well preserved in the material available for study. The position of the transmedian scars (i) is indicated on each valve; also in the ventral valve the space occupied by the central, middle lateral, and outside lateral muscle scars.

Of the vascular markings the main sinuses of the ventral valve are fairly well shown, also the outlines of the parietal scar (Pl. LV, fig. 1g). The presence of a short median ridge is indicated on a cast of the dorsal valve (fig. 1i).

Observations.—This small but very interesting species is most nearly related to *O. chromatica* Billings. It is nearly the same size, has the same type of shell structure, and probably the same surface characters. It differs in being less convex, in having a more transverse dorsal valve, less elongate ventral valve, and the narrower marginal border on the inside of the shell, as shown by comparing Plate LV, figure 1h, with Plate LIV, figure 1h.

The separated valves occur in immense numbers in the shales above the limestone on Smith Point and they are also abundant in a ferruginous limestone at Manuels. The mode of occurrence of the species is very much like that of *O. chromatica*, of which it appears to be the Atlantic coast province representative; hence the specific name.

FORMATION AND LOCALITY.—**Lower Cambrian:** (**5o**) Just below the Middle Cambrian in shales on Smith Point; and (**5n**) shales about 275 feet (84 m.) below the horizon of Locality 5o on Smith Point; both in Smith Sound, Trinity Bay, Newfoundland.

(**5t**) Shale and limestone nodules about 20 feet (6 m.) above the base of the Cambrian, on Redrock Point near Chapple Cove, Hollywood Point; (**41**) *sandstone* [*see Walcott, 1891b, p. 260, for position in section*] *on Manuels Brook;* (**41a**) limestone [Walcott, 1891b, p. 260] on the mainland beneath Topsail Head; and (**5p**) limestone 300 feet (91.4 m.) southeast of the railway station, Manuels; all on Conception Bay, Newfoundland.

(**9n** and **326e**) Dark-purplish siliceous shales on Pearl Street, North Weymouth, Norfolk County; (**326f** [Burr, 1900, p. 47]) 0.5 mile (0.8 km.) south of North Weymouth, Norfolk County; and (**326d**) station 2 of Grabau [1900, p. 610], near North Attleboro, Bristol County; all in Massachusetts.

Specimens compared with this species occur at the following locality:

Lower Cambrian: (**59m**) Weisner quartzite in the Roan iron mine, Bartow County, Georgia.

Obolella chromatica Billings.

Plate LIV, figures 1, 1a–i.

Obolella chromatica Billings, 1861, Geol. Survey Canada, Paleozoic Fossils, vol. 1, pp. 7–8, figs. 7a–d. (Described and discussed as a new species.)

Obolella chromatica Billings, 1861, Report on the Geology of Vermont, vol. 2, p. 947, figs. 346a–d. (Text and figures copied from preceding reference.)

Obolella chromatica Billings, 1862, Report on the Economic Geology of Vermont, by Hager, p. 219, figs. 346a–d. (Text and figures copied from preceding reference.)

Obolella chromatica Billings, 1863, Geol. Survey Canada, Fifteenth Rept. Progress, p. 284, figs. 288a–d. (No text reference. Figs. 288a–d are copied from Billings, 1861b, p. 7, figs. 7a–d, respectively.)

Obolella chromatica Billings, Hall, 1863, Sixteenth Ann. Rept. New York State Cab. Nat. Hist., p. 132, text figure. (Mentioned. The text figure is copied from Billings, 1861b, p. 7, fig. 7c.)

Obolella chromatica Billings, Hall, 1867, Trans. Albany Inst., vol. 5, p. 110. (Text and figure copied from Hall, 1863, p. 132.)

Obolella chromatica Billings, 1876, Am. Jour. Sci., 3d ser., vol. 11, pp. 176–178, figs. 1, 2, 3, p. 176; and figs. 4a–d, p. 177. (Described and discussed. Figs. 4a–d are copied from Billings, 1861b, p. 7, figs. 7a–d, respectively.)

Obolella chromatica Billings, Ford, 1881, Am. Jour. Sci., 3d ser., vol. 21, p. 133, figs. 3 and 4. (Compared with *O. crassa*. Figs. 3 and 4 are drawn from the figures given by Billings, 1876, figs. 1 and 3, p. 176.)

Obolella chromatica Billings, Walcott, 1886, Bull. U. S. Geol. Survey No. 30, figs. 9 and 10, p. 110 and p. 112, Pl. XI, figs. 1, 1a–b. (Copies Billings, 1861b, p. 7, and 1876, pp. 176–177. Figs. 9 and 10 are copied from Billings, 1876, figs. 1 and 3, p. 176. The specimen represented by fig. 1b is redrawn in this monograph, Pl. LIV, fig. 1h.)

Obolella circe Billings, Walcott (in part), 1886, idem, p. 118, Pl. X, fig. 3 (not fig. 3a). (Original description, Billings, 1872a, pp. 219–220, of *Obolella circe* copied. The specimen represented by fig. 3 is redrawn in this monograph, Pl. LIV, fig. 1i. Fig. 3a represents a specimen of *Quebecia circe*.)

Obolella chromatica Billings, Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 611, Pl. LXXI, figs. 2, 2a–b. (Mentioned. Figs. 2, 2a–b are copied from Walcott, 1886b, Pl. XI, figs. 1, 1a–b, respectively.)

Obolella circe Billings, Walcott, 1891, idem, p. 611, Pl. LXXI, fig. 3 (not fig. 3a). (Mentioned. Fig. 3 is copied from Walcott, 1886b, Pl. X, fig. 3. Fig. 3a represents a specimen of *Quebecia circe*.)

Obolella chromatica Billings, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 67, figs. 28 and 29. (Mentioned in the text. Figs. 28 and 29 are copied from Billings, 1876, figs. 1 and 3, respectively, p. 176.)

Obolella chromatica Billings, Walcott, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, p. 446. (Note on generic relations.)

Obolella chromatica Billings, Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 313. (Copied from Walcott, 1899, p. 446.)

General form ovate, with ventral valve obtusely acuminate; dorsal valve broadly rounded, with a tendency to become subacuminate in most specimens. Valves rather strongly convex, with the beak of the ventral valve raised above the plane of the posterior margin, but usually below the greatest elevation of the valve. The beak is slightly incurved over the area of the ventral valve, and that of the dorsal valve terminates at the posterior margin, or may be very slightly curved over it.

Surface of the shell marked by concentric striæ and lines of growth and fine radiating striæ. The latter are usually absent either from the exfoliation of the outer layer of the shell, or from having been abraded before the shell was embedded in sediment. Shell rather thick and formed of several layers or lamellæ within a thin outer layer. The outer layer usually adheres to the matrix, and the inner layers have been so replaced by calcareous matter that the shell appears to be solid. In a few examples the individual layers are preserved, and the oblique lamellæ, encircling the anterior portions of the valves, form imbricating lines where the outer layer has been removed. Billings [1861c, p. 947] described the shell as breaking with a granular fracture, and when weathered as having a tendency to fibrous exfoliation, which is true for the specimens in which the original structure is lost.

The area of the ventral valve is usually lower than the greatest elevation of the surface (Pl. LIV, fig. 1a), but it may be as high as any portion of it (fig. 1c); it projects backward at an angle varying from 45° to 70°. Billings states 45° to 60° from material he studied. The area is divided midway by a narrow pseudo-pedicle furrow (p, fig. 1f). The area of the dorsal valve is well defined in the cast (fig. 1g) and much like that of *O. crassa* (Hall) (fig. 2k) and *O. atlantica* Walcott (Pl. LV, fig. 1l). The two ridges on the cast that converge toward the posterior margin are broader than in any other species except *O.? lindströmi* Walcott (Pl. LV, fig. 4a).

The position of the depressions (a) these ridges filled on the area is shown by figures 1h, 1i; they are triangular areas on each side of a raised, central, triangular space that corresponds in position to the pedicle furrow in species like *Lingulella* (*Lingulepis*) *acuminata* (Conrad) (Pl. XLII, fig. 2a). In *Obolus apollinis* this portion of the area is sometimes slightly elevated, with a depressed furrow on either side (Pl. VII, figs. 6, 7). The cast of the cylindroconical pedicle tube or foramen has been observed in a cast of the interior of the ventral valve (fig. 1e). This is best seen in *Obolella atlantica* (Pl. LV, figs. 1f, 1g, 1h). The external foraminal opening has not been observed.

The muscle scars are unfortunately not well preserved. The general position of the transmedian and anterior laterals is shown in the ventral and dorsal valves (i, j, Pl. LV, figs. 1f, 1g); the centrals (h) and the anterior laterals (j) in the dorsal valve (fig. 1h). The position of the central, middle, and outside lateral muscle scars is indicated in the ventral valve by the outline of the visceral cavity (v) as shown on figures 1e, 1f, but no individual scars can be determined. The outside and middle laterals of the dorsal valve are merged with the transmedian in all the specimens showing them at all; this is undoubtedly owing to the poor preservation of the specimens.

The main trunks of the vascular sinuses are fairly well shown in both valves; also the outline of the parietal scar between the sinuses. A rather strong median ridge occurs in the posterior half of the dorsal valve on which the small anterior lateral muscle scars are situated (Pl. LIV, figs. 1g–i).

Observations.—When the validity of the genus *Obolella* was attacked [Hall, 1867, p. 110] Billings restudied this, the type species, and gave [1876, p. 176] an elaborate description of all the characters he could determine. Through the kindness of the director of the Geological Survey of Canada and of Prof. J. F. Whiteaves, I have had the opportunity of studying the material in the Canadian Survey collection. Prof. Alpheus Hyatt also sent me specimens he collected at L'Anse au Loup and I found some very good specimens in a small collection in the United States National Museum, that were not accessible when I illustrated the species in 1886 [1886b, Pl. XI, figs. 1, 1a–b] and 1891 [1891a, Pl. LXXI, figs. 2, 2a–b]. Among the new characters discovered are: (a) the narrow pseudo-pedicle groove; (b) the cast of the cylindroconical pedicle tube or foramen; (c) the character of the area of the ventral valve; (d) the vascular impressions of the interior of the ventral valve; these taken in connection with the features shown by *O. atlantica* Walcott establishes the genus *Obolella* as distinct from *Obolus* and *Dicellomus*.

The species *O. chromatica* Billings is about the same size as *O. atlantica*, but it differs in outline, convexity, and details of the areas of both valves. I know of no other species with which it is necessary to compare its specific characters. It is in association with *Olenellus thompsoni* and other fossils characteristic of the upper portion of the Lower Cambrian fauna in the Gulf of St. Lawrence and the Lake Champlain region. The bits of limestone brought from Labrador show great numbers of the separated valves, indicating that they occur in large numbers in one or more layers.

Von Toll [1899, p. 27, Pl. I, fig. 27] illustrates a specimen from 3 miles (4.8 km.) beyond Bestjachskaja station, on Lena River, Siberia, which he compares with *Obolella chromatica* Billings. It is too imperfect to determine with any degree of certainty what it may be.

Formation and locality.—**Lower Cambrian**: (392a) *Limestones at L'Anse au Loup, on the north shore of the Straits of Belleisle;* (392c [Billings, 1872a, p. 218]) at the Straits of Belleisle; and (3921) arenaceous limestone at Point Amour, Straits of Belleisle; all in Labrador.

(314f) Limestone of B7 of the section at Bonne Bay [Walcott, 1891b, p. 255], Newfoundland.

(338p) Sandy limestone one-fourth mile (0.4 km.) northwest of schoolhouse No. 7 in Greenwich, Cambridge quadrangle (U. S. Geol. Survey), Washington County, New York.

Obolella crassa (Hall).

Text figure 14, page 299; Plate LIV, figures 2, 2a–n.

Orbicula? crassa Hall, 1847, Nat. Hist. New York, Paleontology, vol. 1, p. 290, Pl. LXXIX, fig. 8a. (Described.)
Avicula? desquamata Hall, 1847, idem, p. 292, Pl. LXXX, figs. 3a and 3b. (Described.)

Obolella (Orbicula?) crassa (Hall), FORD, 1871, Am. Jour. Sci., 3d ser., vol. 2, p. 33. (Merely changes generic reference.)

Obolella crassa (Hall), BILLINGS, 1872, Canadian Naturalist, 2d ser., vol. 6, No. 2, p. 218. (New locality mentioned.)

Obolella desquamata (Hall), BILLINGS, 1872, idem, p. 218, fig. 6, p. 217. (New locality mentioned.)

Obolella crassa (Hall), BILLINGS, 1872, Am. Jour. Sci., 3d ser., vol. 3, p. 356. (Copy of Billings, 1872a, p. 218.)

Obolella desquamata (Hall), BILLINGS, 1872, idem, p. 356, fig. 6, p. 355. (Copy of Billings, 1872a, p. 218, and fig. 6, p. 217.)

Dicellomus crassa HALL, 1873, Twenty-third Ann. Rept. New York State Cab. Nat. Hist., p. 246, Pl. XIII, figs. 6–9. (Generic reference changed.)

Obolella crassa (Hall), FORD, 1878, Am. Jour. Sci., 3d ser., vol. 15, p. 128. (Described and discussed.)

Obolella crassa (Hall), FORD, 1881, idem, vol. 21, pp. 131–133, figs. 1 and 2. (Described and discussed.)

Obolella chromatica (Hall), WALCOTT, 1885, idem, vol. 29, pp. 115 and 117; figs. 1 and 2, p. 116. (Mentioned in the text. Figs. 1 and 2 are copied from Ford, 1881, figs. 1 and 2, respectively, p. 131. They represent *Obolella crassa* and are wrongly referred to in the text, pp. 115 and 117, as *Obolella chromatica*.)

Obolella crassa (Hall), WALCOTT, 1885, idem, vol. 30, p. 21. (Correction of error on pp. 115 and 117 of preceding reference.)

Obolella crassa (Hall), FORD, 1886, idem, vol. 31, fig. 2, p. 466. (No text reference. Fig. 2 is drawn from the specimen figured by Ford, 1881, fig. 1, p. 131.)

Obolella crassa (Hall), WALCOTT, 1886, Bull. U. S. Geol. Survey No. 30, p. 114, Pl. X, figs. 1, 1a–f. (Copies Hall, 1847, p. 290; Ford, 1878, p. 128; and Ford, 1881, pp. 131–133; and discusses species. Figs. 1d and 1f are drawn from the specimens figured by Ford, 1881, figs. 2 and 1, respectively, p. 131. The specimen represented by fig. 1c is redrawn in this monograph, Pl. LIV, fig. 21.)

Obolella crassa (Hall), WALCOTT, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 612, Pl. LXXI, figs. 4, 4a–f. (New locality mentioned. Figs. 4, 4a–f are copied from Walcott, 1886b, Pl. X, figs. 1, 1a–f, respectively.)

Obolella circe? WALCOTT [not BILLINGS], 1891, idem, fig. 62, p. 611. (No text reference.)

Obolella crassa (Hall), HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, Pl. III, figs. 5–7. (No text reference.)

Obolella crassa (Hall), HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 70, Pl. II, figs. 31–36. (Discussed. Fig. 33 is drawn from the specimen figured by Hall, 1847, Pl. LXXX, figs. 3a–b. Figs. 32, 36, and 34 are copied from figs. 5–7, respectively, of the preceding reference.)

Obolella crassa (Hall)?, GRABAU, 1900, Occas. Papers Boston Soc. Nat. Hist., No. 4, vol. 1, pt. 3, pp. 619–620, Pl. XXXI, fig. 3. (Described.)

Obolella crassa (Hall), WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 321. (Discussed.)

Obolella crassa (Hall), GRABAU and SHIMER, 1907, North American Index Fossils, vol. 1, pp. 188–189, figs. 222e–g, p. 188. (Described. Figs. 222e–g are copied from Walcott, 1886b, Pl. X, figs. 1, 1e, and 1c, respectively.)

General form ovate to suborbicular, with the ventral valve bluntly acuminate in some examples. Considerable variation in outline occurs, as is shown by Plate LIV, figures 2, 2a, 2b of the ventral valve, and 2k, 2 l of the dorsal valve. Valves moderately convex, with the beak of the ventral valve depressed below the greatest elevation of the surface and slightly curved over the low area; the beak of the dorsal valve terminates at the posterior margin.

Surface of the shell marked by rather strong, concentric striæ and lines of growth that interrupt the continuity of fine radiating lines; it is rarely that the surface is well preserved; usually the shells are smooth as though they had been abraded. Shell rather thick, and formed of several layers or lamellæ that are more or less oblique to a thin outer layer; the short oblique lamellæ encircling the anterior portion of the valves form imbricating lines when the outer surface is removed (Pl. LIV, fig. 2b). Very few shells show the shell structure; usually the calcareous matter has so far replaced the original shell that there is only a solid calcareous, granular, or calcite shell, as shown by the broken section (fig. 2f). The weathered surface often has a fibrous appearance similar to that of the shell of *Obolella chromatica* Billings.

The area of the ventral valve is usually short, but it varies considerably in this respect (Pl. LIV, figs. 2g, 2h, 2j). It overhangs the posterior margin at an angle varying from 45° to 70° and extends well out onto the cardinal slopes; fine striæ of growth parallel to the margin cross the area and pass into and across the central furrow; a narrow furrow divides the area midway (Pl. LIV, figs. 2g, 2h, and 2j). The specimen represented by figure 2h has a rounded cardinal area and a very shallow median furrow; a small pedicle opening is outlined beneath the rounded area, but it is not shown in the illustration. A tendency of the inner point of the area next to the furrow to thicken and project forward into the cavity of the shell is found in several specimens, but it is not as pronounced as in *Obolella atlantica* Walcott. The area

of the dorsal valve is flat and marked midway by a slightly raised triangular space with depressed triangular spaces on each side; what appear to be flexure lines cross the area very much as they do in the area of the dorsal valve of *Obolus apollinis* Eichwald. Pedicle tube or foramen of ventral valve small, cylindroconical. It has been observed in a broken section of the posterior portion of one shell (Pl. LIV, fig. 2n). The external foraminal opening is a little in advance of the extreme end of the beak.

The muscle scars are more clearly shown in *O. crassa* than in any other species of the genus. The transmedians (i) in both valves are near the margin of the area and close to the main vascular sinuses; the outside and middle laterals (l) of the dorsal valve can not be separated, but their position a little in advance and slightly outside of the transmedian is well indicated on the casts of the interior (Pl. LIV, figs. 2k and 2l); the anterior laterals of the ventral valve are shown by figure 2h at j, a little in advance and outside of the transmedian, also in the dorsal valve as small oval scars each side of the median line near the center of the shell; the central scars (h) of the dorsal valve are elongate, oval, and situated on the inner edge of a groove bounding the visceral cavity, about one-fourth of the distance between the anterior lateral scars and the posterior margin of the shell; the central, middle lateral, and outside lateral scars of the ventral valve have not been differentiated; the area (c) in which they should occur (Pl. LIV, figs. 2g and 2h) is clearly outlined in a number of specimens; the pedicle and umbonal scars have not been observed.

The main vascular sinuses of the ventral valve are strongly marked and extend forward well toward the front margin of the shell; they vary in form and position in different shells largely on account of the thickness and manner of deposit of the shell substance. The figures 2g–j illustrate better than any description I can give the character of the sinuses and the principal variations as far as known to me. In the dorsal valve the main sinuses extend farther out from the median line than in the ventral, but they are small and inconspicuous when compared with the latter or with the strongly impressed grooves on each side of the visceral cavity. The latter grooves rise to give the peculiar ridges having the appearance of frog legs that are so strongly marked in the cast of the dorsal valve of *Obolus* (*Lingulobolus*) *spissus* (Billings) (Pl. XVI, fig. 2d).

Observations.—In a former paper [1886b, pp. 114–116] I have quoted the descriptions of this species by Hall and Ford. With the material now available and our more detailed information of the genus, it is unnecessary to repeat or to comment on those descriptions or on the slight additions made by myself, except the reference made to *Avicula? desquamata* Hall.

Billings [1861b, p. 7] thought that *Avicula? desquamata* Hall might be referred to *Obolella*, and Ford [1871, p. 33] referred *Orbicula? crassa* Hall to the same genus. Later [1878, p. 128] the latter observer placed *Avicula? desquamata* as a synonym of *O. crassa*, saying:

> The species known as *Obolella crassa* of the Troy beds may also be briefly noticed in this connection. It includes the species already widely known under the name of *O. desquamata* from the same locality, this latter, as may be shown, having been founded upon the dorsal valve of the former. The ventral valve is always more acutely pointed at the beak than the dorsal, but beyond this feature there is nothing, so far as I have been able to discover, by which they may be distinguished from each other externally. The surface of each when perfect is both radiately and concentrically striated. As a rule, however, the imbricating edges of the successive layers of growth are the only markings visible.

Obolella crassa is one of the large species of the genus. There is no closely allied species on the American Continent, but *O. mobergi*, of Sweden, may be considered as such in the Scandinavian Cambrian faunas. Some examples of the outer surface of *O. mobergi* resemble *O. crassa*, but a careful comparison of the form and also of the interior of the valves shows striking specific differences (Pls. LIV and LV). The presence of a well-marked median furrow on the area of the ventral valve and a relatively small pedicle tube are noticeable features in *O. crassa*.

Obolella crassa is very abundant in some of the limestone layers interbedded in the siliceous shales at Troy, New York. It also occurs in the limestone conglomerate of the same region. It is associated with the *Elliptocephala asaphoides* fauna in the Hudson Valley, and a similar fauna is found in the limestone bowlders of the Bic conglomerate in the St. Lawrence

Valley. I have found no traces of it in the Atlantic province Cambrian formations. Stratigraphically, it is, I believe, the oldest representative of its genus in America.

FORMATION AND LOCALITY.—**Lower Cambrian:** (**392c** [Billings, 1872a, p. 218]) At the Straits of Belleisle, Labrador.

(**56b**) Limestone bowlder in conglomerate, on the south shore of Orleans Island, below Quebec; (**2o**) limestone bowlders in conglomerate, on shore at east entrance to harbor at Bic, Rimouski County; and (**319b**) conglomeratic limestones containing *Olenellus?*, at St. Simon; all in Quebec, Canada.

(**319k**) Calcareous sandstone near the base of the section west of Parker's quarry, on cliff overlooking Lake Champlain, east of Georgia, Franklin County, Vermont.

(**2b**)[a] Limestone just north of Beman Park, in the northeastern part of the city of Troy, Troy quadrangle (U. S. Geol. Survey); (**27**) even-bedded and conglomerate limestones on the ridge in the eastern suburb of Troy, Troy quadrangle (U. S. Geol. Survey); (**338q** [*Hall, 1847, p. 290*]) *calcareous beds 2 miles (3.2 km.) northeast of Troy, Troy quadrangle (U. S. Geol. Survey);* (**27a**) reddish sandstone about 1 mile (1.6 km.) east of Lansingburg, north of Troy, Cohoes quadrangle (U. S. Geol. Survey); and (**29a**) limestone 1 mile (1.6 km.) below the New York Central Railroad depot at Schodack; all in Rensselaer County, New York.

(**338o**) Shale on Moses Hill, 2 miles (3.2 km.) west of North Greenwich; and (**35**) limestones 1.5 miles (2.4 km.) north of Bald Mountain; both in the Schuylerville quadrangle (U. S. Geol. Survey), Washington County,[b] New York.

(**326d**) "Station 2" of Grabau [1900, p. 610] near North Attleboro, Bristol County; and (**326g** [Grabau, 1900, p. 620]) limestones at East Point, Nahant, Essex County; both in Massachusetts.

Specimens that are somewhat doubtfully referred to this species occur at the following localities:

Lower Cambrian: (**50a**) Sandstone 2 miles (3.2 km.) northwest of York, York County; and (**12v**) sandstone above the quartzite 1 mile (1.6 km.) west of Fruitville on Little Conestoga Creek, Manheim township, Lancaster County; both in Pennsylvania.

(**59m**) Weisner quartzite in the Roan iron mine, Bartow County, Georgia.

OBOLELLA CRASSA ELONGATA n. var.

Plate LV, figures 5, 5a.

In the collections from St. Simon there is an oval or elongate ovate form to which it appears to be desirable to give a varietal name. Its surface is marked by stronger concentric lines of growth than usually occur on the less elongate shells of *O. crassa* (Hall), and the valves, especially the dorsal, are much more elongate than those of *O. crassa*. One ventral valve of the latter species from Troy, New York, is nearly as elongate (Pl. LIV, fig. 2a), but it is broader on the posterior half of the shell than those from St. Simon referred to the variety *elongata*.

FORMATION AND LOCALITY.—**Lower Cambrian:** (**319b**) Conglomeratic limestones containing *Olenellus?*, St. Simon, Province of Quebec, Canada.

OBOLELLA GROOMI Matley.

Text figure 52, page 596.

Obolella (?) groomi MATLEY, 1902, Quart. Jour. Geol. Soc. London, vol. 58, pt. 1, pp. 137 and 139, figs. 1–2, p. 137.
(Described and discussed as a new species, see below for copy. Fig. 1 is copied on p. 596 as fig. 52.)

The original description by Matley follows:

Shell oval, moderately convex, about as long as wide, widest toward the front, which is moderately to well rounded. Lateral margins straight or slightly convex, converging posteriorly to form a rounded beak. Hinge-area absent, or not well defined. Sides usually somewhat deflected. Surface covered by about thirty small but well-marked, concentric, rugose ridges. No radial striæ. Casts of the interior show nothing but very faint traces of markings.

About 4.5 mm. long by 5 mm. wide. Type in Professor Groom's collection. Other specimens measure:

Length. mm.	Width. mm.
7	5.5
5.5	5
4.5	4.75

[a] The species also occurs at Locality 2d.

[b] This species also occurs at Locality 20.

Several specimens of this shell have been collected by Prof. Theodore Groom, in honor of whom the specific name is given. With no knowledge of its internal characters, the generic reference is necessarily provisional, but the species approaches in outline and external characters some American forms of the genus *Obolella*, especially the type species of the genus, *O. chromatica* Billings, of the *Olenellus* zone of Canada, from which, however, it appears to be separated by the form of the beak and the shape of the umbonal region.

A A'

FIGURE 52.—*Obolella groomi* Matley. A, A', Top and side views of a ventral valve. The figures are copied from Matley [1902, p. 137, fig. 1].

There is little to add to Matley's description and observations, except to call attention to the resemblance in general form and surface of this species to the figure of *Obolella crassa elongata* on Plate LV, figure 5. As described and illustrated the species appears to be a true *Obolella*.

FORMATION AND LOCALITY.—**Lower Cambrian:** (**304c**)[a] "Malvern quartzite" at Raggedstone Hill; and (**304d**)[a] "Malvern quartzite" at Midsummer Hill; both [Groom, 1902, p. 94] in the Malvern Hills, between Herefordshire and Worcestershire, England.

OBOLELLA? LINDSTRÖMI Walcott.

Plate LV, figures 4, 4a.

Obolella lindströmi WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 674–675. (Characterized and discussed essentially as below as a new species.)

This species differs from *Obolella mobergi* Walcott in the more subacuminate outline of the valves, the surface characters, and the interior of the dorsal valve. The last is well shown by comparing figures 3e and 4a (Pl. LV). Figures 3 and 4 clearly indicate the difference in surface of the two species. The surface of *O.? lindströmi* is much like that of *Bicia gemma* (Pl. L, figs. 1a and 1d).

The ventral valve (Pl. LV, fig. 4) occurs in a hard gray sandstone of the *Mesonacis torelli* zone, and the cast of the dorsal valve (fig. 4a) is from one of the brown sandstone masses that occur within the gray sandstone at Sularp. I am not sure that the dorsal valve illustrated actually belongs to this species, as it is not associated with the typical ventral valve. It differs from the typical dorsal valves of *O. mobergi* in being more acuminate, and there is no corresponding ventral valve associated with it in the material studied.

I take pleasure in naming the species in honor of Dr. G. Lindström, to whom all paleontologists are deeply indebted for his many fine contributions to the paleontology of the Silurian formations of Scandinavia.

FORMATION AND LOCALITY.—**Lower Cambrian:** (**321v**) *Gray sandstone of the Mesonacis torelli zone at Bjorkelunda, south of Simrishamn, Province of Christianstad;* and (**321s**) brown sandstone interbedded in gray sandstone at Sularp, near Lund, Province of Malmöhus; both in Sweden.

OBOLELLA MINOR (Walcott).

Plate LIV, figures 3, 3a–d.

Camerella minor WALCOTT, 1890, Proc. U. S. Nat. Mus. for 1889, vol. 12, pp. 36–37. (Described and discussed as a new species.)

Camarella? minor WALCOTT, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 614, Pl. LXXII, figs. 4, 4a–d. (Text copied from preceding reference. Figs. 4, 4a–d are copied in this monograph, Pl. LIV, figs. 3b, 3, 3c, 3d, and 3a, respectively.)

Camarella minor Walcott, HALL and CLARKE, 1894, Nat. Hist. New York, Paleontology, vol. 8, pt. 2, p. 221. (Characterized and discussed.)

Protorhyncha? minor (Walcott), SCHUCHERT, 1897, Bull. U. S. Geol. Survey No. 87, p. 334. (Generic reference changed and generic relations discussed.)

Obolella minor (Walcott), CLARK and MATHEWS, 1906, Maryland Geol. Survey, vol. 6, 1906, pt. 1, p. 252, Pl. XVI, figs. 13 and 14. (No text reference. Figs. 13 and 14 are copied from Walcott, 1891a, Pl. LXXII, figs. 4a and 4c, respectively.)

General form ovate, biconvex. Surface smooth or marked by concentric lines and varices of growth. Ventral valve subacuminate, moderately convex, with the most elevated portion at the umbo, which curves downward toward the small apex; the posterior or umbonal third

[a] Neither Groom [1902, p. 94] nor Matley [1902, p. 137] states which of these localities is the type locality.

of the valve is usually more or less tumid, a ridge of growth separating it from the anterior portion of the shell; area nearly on the plane of the margins of the valve and divided midway by a narrow, deep, pedicle furrow; casts of the interior show that the area formed a shelf on each side of the pedicle furrow. Dorsal valve transversely ovate; a narrow, short area and a slight median ridge are indicated on a cast of the interior.

This shell is small. A large ventral valve measures, length, 7 mm.; width, 6 mm.; a dorsal valve, length, 6 mm.; width, 6.5 mm.

Observations.—The characters of this little shell, as far as they are known, are those of *Obolella*. In my original description I gave an erroneous interpretation to the cast of the interior of the ventral valve. At that time I did not know much of the interior of *Obolella*, and also considered the cast of the space beneath the area beside the pedicle groove as indicating the existence of plates as in *Pentamerus*. In the absence of the shell or fine casts it is impossible to determine conclusively whether a foraminal tube existed, as in *Obolella atlantica* Walcott, or not; one cast indicates that such was the case. The form and long area distinguish this from other species of the genus.

Formation and locality.—**Lower Cambrian:** (**16f**) Sandstone at the mouth of Little Antietam Creek, near Eakles Mills; (**47d**)[a] sandstones 1 mile (1.6 km.) east-southeast of Smithsburg; (**47e**) sandstone on Observatory Hill, 2 miles (3.2 km.) south of Keedysville; and (**47f**) sandstone at Eakles Mills, 2 miles (3.2 km.) south of Keedysville; all in Washington County, Maryland.

(**32**) *Sandstone on the south slope of Stissing Mountain, Dutchess County, New York.*

(**49b**) Sandstone 2 miles (3.2 km.) northwest of Emigsville, York County; (**49c**) sandstone in ridge just north of the railway station in Emigsville, York County; (**49d**) sandstone 3 miles (4.8 km.) east of Waynesboro, Franklin County; (**49e**) sandstone 1 mile (1.6 km.) south of Mount Zion Church, and 4 miles (6.4 km.) northeast of York, York County; and (**49f**)[a] sandstones of Mount Holly Gap, South Mountain, Cumberland County; all in Pennsylvania.

(**47a**) Sandstone on the southwest side of Sallings Mountain, 2 miles (3.2 km.) east of Natural Bridge, Rockbridge County, Virginia.

(**47c**) Sandstone 2 miles (3.2 km.) west of Harpers Ferry, Jefferson County, West Virginia.

Obolella mobergi Walcott.

Plate LV, figures 3, 3a–f.

? Obolus? sp. Kjerulf, 1873, Om Skuringsmærker, Glacialformationen, Terrasser, og Strandlinier, etc., 2: Sparagmitfjeldet, p. 83, figs. 10 and 11. (No text reference.)

Obolella mobergi Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 673–674. (Described and discussed as below as a new species.)

General form ovate, with the ventral valve subacuminate and the dorsal valve obtusely subacuminate; valves moderately convex; beak of the ventral valve slightly elevated above the plane of the shell; beak of the dorsal valve curved down to the plane of the margin. Surface of the shell marked by concentric lines and striæ of growth, and in some examples by rather strong, radiating, broken, and slightly irregular raised lines of the same character as those of *Bicia gemma* (Billings). The shell is formed of a thin outer layer, and numerous inner layers or lamellæ over the anterior half of the shell. These imbricating inner lamellæ are oblique to the outer layer, very much as in *Obolella (Glyptias) favosa* (Linnarsson).

A ventral valve 10 mm. in length has a width of 9 mm. A dorsal valve 9 mm. long has the same width.

The area of the ventral valve is of medium length and tipped back from the edge of the valve to meet the beak; it extends well out onto the cardinal slopes, and is divided midway by a narrow furrow. The surface of the area is marked by rather strong transverse striæ crossing the area. On each side of the base of the pedicle tube there is a rather strong undercut which in the cast is replaced by a marked toothlike projection. The area of the dorsal valve is narrow. The cast of the pedicle tube or foramen is large, cylindroconical, and encircled by a number of rather strong lines of growth (Pl. LV, fig. 3c).

The casts of the interior of the ventral valve show a central visceral area, very much like that in *O. crassa* (Hall); also two strongly marked vascular sinuses that extend well into the

[a] Doubtfully identified from this locality.

middle of the valve. No clearly defined muscle scars are shown on any of the specimens. Casts of the interior of the dorsal valve give little satisfactory data in relation to the muscle scars. The cast illustrated by Plate LV, figure 3e, shows a part of the outline of the visceral area, also the impression of the transmedian muscle scar.

Observations.—This species has been considered as the European representative of *O. crassa* (Hall), which occurs at the same relative stratigraphic horizon at Troy, New York. The Swedish form differs specifically from the American in having a slightly more elongate pedicle tube and in having the interior thickenings of the area more strongly developed. It differs from *O. atlantica* Walcott and *O. chromatica* Billings in having a much more robust shell and in many slight details.

Kjerulf [1873, p. 83, figs. 10 and 11] illustrates, without text reference, a form that appears to be referable to this species. It is found in Locality 324, at Tomten, Norway, in association with *Holmia kjerulfi*, *Arionellus*, and *Obolella* (*Glyptias*) *favosa*.

The specific name was given in honor of Dr. J. C. Moberg.

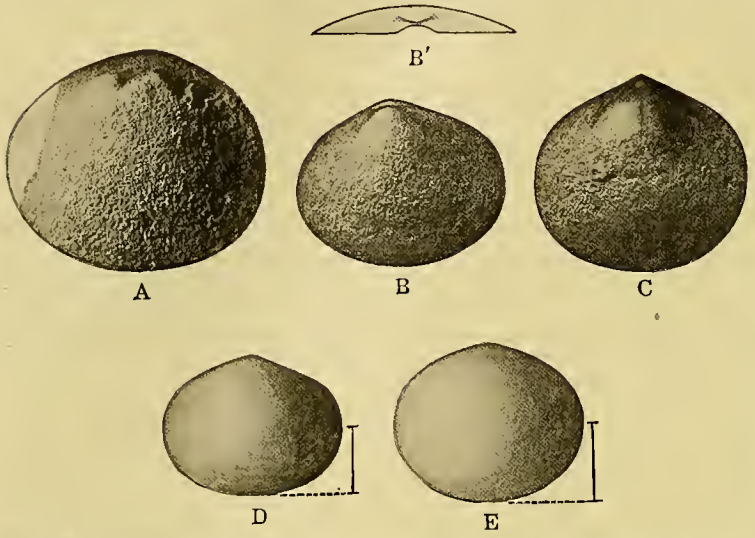

FIGURE 53.—*Obolella vermilionensis* n. sp. A, Cast of the interior of a ventral valve, the type specimen (× 2), from Locality **60b**, Lower Cambrian sandstones in Vermilion Pass, Alberta, Canada (U. S. Nat. Mus. Cat. No. 56606a). B, B′, Top and back views of a dorsal valve associated with the specimen represented in figure 53A (× 2) (U. S. Nat. Mus. Cat. No. 56606b). C, Ventral valve preserving its shape but from which all traces of shell substance have been removed (× 2). It is associated with the specimens represented by figures 53A and 53B (U. S. Nat. Mus. Cat. No. 56606c). D, Ventral valve from Locality **14p**, Lower Cambrian sandstones near Resting Springs, California (U. S. Nat. Mus. Cat. No. 51964a). E, Associated dorsal valve, Locality **14p** (U. S. Nat. Mus. Cat. No. 51964b).

FORMATION AND LOCALITY.—**Lower Cambrian:** (**321v**) Gray sandstone of the *Mesonacis torelli* zone at Bjorkelunda, south of Simrishamn, Province of Christianstad; and (**321s**) *brown sandstone interbedded in gray sandstone at Sularp, near Lund, Province of Malmöhus;* both in Sweden.

(**8v**) Shales and dark, calcareous, ferruginous rock in the upper portion of the *Holmia kjerulfi* zone, Ringsaker; and (**324** [Kjerulf, 1873, pp. 73 and 83]) green shales with interbedded calcareous sandstone at Tomten, in Ringsaker; both in the Province of Hedemarken, Norway.

OBOLELLA VERMILIONENSIS n. sp.

Text figures 53A–E.

This species is represented by numerous casts in a fine-grained sandstone. General form suborbicular, slightly transverse. Shells fairly convex and uniformly larger than those of the other species of the genus.

The beak of the ventral valve is somewhat lower than the greatest elevation of the shell, and does not reach the posterior margin. Both the beak and the area are, as a rule, poorly preserved, but the incurving of the growth lines to form the area is well shown in several specimens. Interior casts of the ventral valve show traces of vascular sinuses.

The beak of the dorsal valve terminates at the posterior margin, but is raised slightly above the plane of the margin of the shell.

Shell substance not preserved, but the casts show indications of both radial and concentric striation.

Observations.—The representatives of this species occur in such widely separated parts of the Rocky Mountain province as California and British Columbia, but the forms are identical and are associated in each district with *Holmia* and *Orthotheca*.

Obolella crassa approaches this species in the size of some of its specimens, but it is uniformly smaller and less convex. *Obolella vermilionensis* also differs from the former species in its transverse outline. Further comparison is impossible because of the lack of knowledge as to the interior of *Obolella vermilionensis*.

FORMATION AND LOCALITY.—**Lower Cambrian:** (**60b**) *About 2,300 feet (702 m.) below the Mount Whyte formation and 200 to 300 feet (61 to 92 m.) above the Lake Louise shale, in the St. Piran sandstone [Walcott, 1908a, p. 4], at Vermilion Pass, on the Continental Divide between British Columbia and Alberta, west-southwest of Castle, on the Canadian Pacific Railway, Alberta, Canada.*

(**53**) Sandstones in the lower portion of 3d of the Waucoba Springs section [Walcott, 1908f, pp. 187 and 188], 1 mile (1.6 km.) east of the Saline Valley road about 2.5 miles (4 km.) east-northeast of Waucoba Springs; (**312a**) sandstones of 3b of the Waucoba Springs section [Walcott, 1908f, p. 187], east of the Saline Valley road east of Waucoba Springs; (**14p**) sandstone near Resting (Freshwater) Springs, which is in the southwest corner of T. 21 N., R. 8 E., on Amargosa River; (**8b**) limestone in Tollgate Canyon, about 15 miles (24.2 km.) east of White Pine, White Mountain Range; and (**176**) shales and interbedded limestones, between massive limestones carrying *Archæocyathus*, at the south end of Deep Spring Valley; all in Inyo County, California.

OBOLELLA WIRRIALPENSIS Etheridge.

Plate LV, figures 7, 7a–b.

Obolella wirrialpensis ETHERIDGE, 1905, Trans. Roy. Soc. South Australia, vol. 29, p. 248, Pl. XXV, figs. 2 and 3. (Described and discussed as a new species. The specimen represented by fig. 2 is redrawn in this monograph, Pl. LV, fig. 7b.)

Obolella wirrialpensis calceoloides ETHERIDGE, 1905, idem, p. 249, Pl. XXV, figs. 4–6. (Characterized and discussed as a new variety. The name placed at the head of the paragraph is "*Obolella* sp.," the term *calceoloides* being applied to it in the text.)

The original description by Etheridge follows:

Valve (? pedicle) ovate to subquadrate, gently convex, rising dorsally into a small umbo; rounded ventrally and without emargination; lateral angles rounded. Internal muscle scars hardly at all curved, diverging from one another, extending far forward, and tapering to a fine point. Surface characters very marked and distinctive, consisting of a series of clean-cut, flat, concentric steps, the "tread" of each step practically at right angles to its "riser;" no concentric or radial striæ of any kind.

After a study of the type specimens of this species and several specimens that were worked out of a block of the limestone received from Mr. Walter Howchin, of the University of Adelaide, I have concluded that the variety *calceoloides* is a narrow form of the species. There are a number of intermediate forms which render it difficult to separate a distinct variety. The species resembles *Obolella crassa* (Hall) in outline and convexity more than any other species referred to the genus.

The specific name is derived from Wirrialpa, the type locality.

FORMATION AND LOCALITY.—**Lower? Cambrian:** (**315d** [Etheridge, 1905, p. 248]) Limestone near Wirrialpa, Flinders Range, South Australia.

OBOLELLA? sp. undt.

Obolella cf. *atlantica* DELGADO, 1904, Communicações Commissão Serviço Geol. Portugal, tome 5, fasc. 2, p. 364, Pl. IV, fig. 35. (Described in French.)

This form, Delgado states [1904, p. 364], is represented by a single specimen, which he compares with *Obolella atlantica* Walcott. The material is too poor to base a specific determination upon. The photograph of the cast of the interior of a small ventral valve 4.5 mm. long and 6 mm. wide indicates that the specimen may be referred to this genus, but it may belong to *Trematobolus, Botsfordia,* or an allied genus.

The *Obolella maculata* referred to by Delgado [1904, p. 364] has in this monograph been referred to *Acrothele villaboimensis.*

FORMATION AND LOCALITY.—**Lower Cambrian:** (**351** [Delgado, 1904, p. 364]) Shales at Monte de Valbom, to the northeast of Villa Boim, Province of Alemtejo, Portugal.

GLYPTIAS Walcott,[a] subgenus of OBOLELLA.

Obolella (*Glyptias*) WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 675. (Mentioned as below as a new subgenus.)

Obolella (*Glyptias*) WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 145. (Classification of subgenus.)

The subgenus *Glyptias* is based on the peculiar surface sculpture and the very short area.

Type.—Lingula (*?*) *favosa* Linnarsson.

[a] Prior to the definition of this subgenus the type species was described under *Lingula?* Linnarsson [1869a, p. 356; 1869b, p. 406].

Obolella (Glyptias) favosa (Linnarsson).

Plate LV, figures 2, 2a–d.

Lingula (?) favosa Linnarsson, 1869, Öfversigt af K. svensk. Vet.-Akad. Förhandl. for 1869, vol. 26, No. 3, pp. 356–357. (Described and discussed in Swedish as a new species.)

Lingula (?) favosa Linnarsson, 1869, Geol. Mag., vol. 6, p. 406. (Translation of the preceding reference.)

? Discina? sp. Kjerulf, 1873, Om Skuringsmærker, Glacialformationen, Terrasser, og Strandlinier, etc., 2:Sparagmitfjeldet, p. 83, figs. 12 and 13. (No text reference.)

Obolella (Glyptias) favosa (Linnarsson), Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, pp. 675–676. (Described and discussed essentially as below.)

General form ovate, with the ventral valve subacuminate and the dorsal valve obtusely rounded; valves moderately convex. The dorsal valve is abruptly curved downward at the beak to the plane of the edge of the shell, while the beak of the ventral valve is slightly above the margin, the posterior edges of the shell curving up to meet it. Surface of the shell marked by very fine concentric lines or striæ of growth, crossed transversely by undulating, slightly lamellose lines in almost identically the same manner as in *Obolus* (*Westonia*) *stoneanus* (Whitfield) of the Upper Cambrian of Wisconsin (Pl. XXVIII, fig. 2d). When the outer surface of the shell is exfoliated or worn off by attrition, which is the usual condition, the surface of the inner layers shows fine radiating and concentric striæ. The shell is formed of a very thin, highly ornamented outer layer and numerous inner layers or lamellæ; the latter over the anterior portions are oblique to the outer layer, and when the shell is partly exfoliated they appear as imbricating layers very much as in *Obolus matinalis* (Hall).

The largest ventral valve in the collection has a length of 7 mm. and a width of 6 mm. An associated dorsal valve 6 mm. long has a width of 6.25 mm.

The area of the ventral valve is narrow and rises slightly to meet the beak, which is elevated above the posterior margin. The pedicle tube or foramen is short and small, and, judging from the appearance of the specimens where the beak of the valve is broken away, it opened near the apex of the beak. On the dorsal valve there is no evidence of a true area except in the presence of a narrow, thickened rim somewhat like that of the dorsal valve of *Bicia gemma* (Billings). None of the muscle scars are shown in the ventral valve. The position of the central and anterior lateral scars of the dorsal valve is indicated near the outline of the visceral cavity (Pl. LV, fig. 2c). Of the vascular markings, the main sinuses are clearly shown in each valve, also the outline of the parietal scar. All that is known of them is well shown on Plate LV.

Observations.—This beautiful little shell has remained without illustration since Linnarsson [1869a, p. 356] gave it a name, based on the "singular sculpture" of the outer shell. In a collection made for me by Mr. Schmalensee, a collector in the Geological Survey of Sweden, there were several specimens showing casts of the interior more or less imperfectly. From these I was able to ascertain that the shell has the generic characters of *Obolella*, although differing from the typical species of that genus in the character of the surface ornamentation. The outer surface has been seen only on the posterior umbonal portion of the valves in the shells collected.

Kjerulf [1873, p. 83, figs. 12 and 13] illustrates, without text reference, a form that appears to be referable to this species. It occurs in Locality 324 at Tomten, Norway, in association with *Obolella mobergi*, *Holmia kjerulfi*, and *Arionellus*.

Formation and locality.—Lower Cambrian: (309c)[a] "Fucoid sandstone" at Billingen, east of Skara; and (309d) *"fucoid sandstone" at Lugnås, 8 miles (12.8 km.) south-southeast of Mariestad;* both [Linnarsson, 1869a, p. 357] in the Province of Skaraborg, Sweden.

(324 [Kjerulf, 1873, pp. 73 and 83]) Green shales with interbedded calcareous sandstone at Tomten, in Ringsaker, near Lake Mjösen, Province of Hedemarken, Norway.

[a] Specimens from this locality are included in the collections of the United States National Museum.

Genus BOTSFORDIA Matthew.[a]

Obolus (*Botsfordia*) Matthew, 1891, Trans. Roy. Soc. Canada for 1890, 1st ser., vol. 8, sec. 4, No. 6, p. 148. (Merely uses the term "*Obolus* (*Botsfordia*) *pulcher*" in the text.)

Obolus (*Botsfordia*) Matthew, 1892, Trans. Roy. Soc. Canada for 1891, 1st ser., vol. 9, sec. 4, No. 5, p. 63. (Merely proposed as a new subgenus.)

Lingulella Hall and Clarke (in part), 1892, Eleventh Ann. Rept. State Geologist New York for 1891, pp. 232–233. (The genus *Lingulella* is described, *Lingulella davisi* being given as the type, but *Botsfordia cælata* is figured as the generic illustration on Pl. III.)

Lingulella Hall and Clarke (in part), 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 55–59. (The genus *Lingulella* is described and discussed, but figures of *Obolus* (*Westonia*) *ella* accompany the text, and *Botsfordia cælata* is figured as the generic illustration on Pl. II. Species belonging with other genera are also mentioned as belonging to *Lingulella*.)

Mobergia Redlich, 1899, Mem. Geol. Survey India, Paleontologia Indica, new ser., vol. 1, No. 1, Cambrian Fauna of the Eastern Salt Range, pp. 5–6. (The description of this new genus is incorporated with that of the new species "*Mobergia granulata*.")

Botsfordia Matthew, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 145. (Classification of genus.)

General form moderately convex, subcircular, with the ventral valve more or less obtusely acuminate and the dorsal valve oval. Ventral valve with the beak (apex) close to the posterior margin, perforated with a minute pedicle opening that is separated from the posterior margin by a very short listrium; posterior margin arched above the plane of the side and front margins of the valves. Dorsal valve with a minute beak at the margin.

Surface with concentric lines and ridges of growth and a more or less regular system of tubercles resting upon concentric, rounded, regular or irregular, separate or inosculating ridges; the tuberculated or granulated surface may cover the entire shell or only a portion of it; the tubercles may be arranged in regular order, as in *Botsfordia pulchra* (Matthew) (Pl. LXII), or irregularly, as in *B. granulata* (Redlich) (Pl. LVII).

The shells are small, rarely exceeding a length of 12 mm. Substance corneous, or phosphate of lime and chitin.

Structure of shell lamellated, the inner lamellæ being more or less oblique to the outer layer.

Interior of ventral valve with a small visceral area not exceeding one-half the length of the valve; the pedicle opening is at the posterior end of the visceral area, where the shell usually has its greatest thickness. Vascular sinuses strong, and well within the body of the valve. Muscle scars arranged essentially as in *Obolus;* the transmedian and anterior lateral are close to the main vascular sinus and well back toward the posterolateral part of the valve. So far as known, the centrals and the middle and outside laterals are grouped on each side of the front of the visceral area.

Interior of dorsal valve much like that of *Acrothele*, except that the transmedian muscle scars are separable from the outside and middle lateral scars in one species, *Botsfordia granulata* (Redlich); otherwise they appear to be grouped within the cardinal muscle scar. Median ridge long and prominent; main vascular sinuses well developed and well within the sides of the valve; visceral area in the adult usually not more than one-half the length of the valve; central and anterior lateral muscle scars near the center of the valve.

Type.—*Obolus pulcher* Matthew.

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[a] The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Botsfordia* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Orbicula Hall [1847, p. 290].
Brachiopode, nouv. gen. [de Verneuil and Barrande, 1860, p. 536].
Obolella (*Orbicula*) Ford [1871, p. 33].
Obolella Billings [1872a, p. 218].
Lingulella Walcott [1886b, p. 95; 1887, p. 199].
Lingulella? Matthew [1888, p. 28].
Obolus Matthew [1889, p. 306; 1890, p. 151].
Lingulella Walcott [1891a, p. 607].
Obolus? Hall and Clarke [1892c, pp. 81 and 183].
Obolus (*Botsfordia*) Matthew [1894, p. 90; 1895a, p. 115].
Lingulella Matthew [1895a, p. 126].
Acrothele Pompeckj [1896b, p. 603].
Obolus (*Lingulella*) Walcott [1901, p. 688].
Obolus (*Botsfordia*) Matthew [1902c, p. 95].

Matthew [1895a, Pl. III] has given diagrammatic illustrations and elaborate descriptions of a number of "embryonic" characters of *Botsfordia pulchra*. Prof. W. A. Parks, of the University of Toronto, sent me (in July, 1906) all the material in the Matthew collection representing this genus and species, but I was unable to recognize the originals from which Matthew's drawings were made. It does not seem probable that his figures 2a, 2b, and 2c represent a young shell of this genus, as it is represented with a high false area similar to that of some species of *Acrothele;* the same is true of figure 2g. Of the other figures, 1k, 2k, and 2i appear to be the posterior portions of adult shells from which the anterior portions have been broken away.

There are two slabs of rock in the Matthew collection upon which there are a number of distorted and poorly preserved interiors of the valves, some of which may have been used in constructing restorations of the interior characters.

Matthew [1891, p. 148] regarded *Botsfordia* as a subgenus of *Obolus*, as he did not discover that the ventral valve was perforated with a pedicle opening and that the dorsal valve was much like that of *Acrothele*. Redlich [1899, pp. 5–6] proposed the genus *Mobergia* for a generically similar species, therefore his name becomes a synonym of *Botsfordia*. Redlich [1899, p. 6] compares *Mobergia* with *Obolella*, an observation that was based on keen appreciation of the cleft or pedicle groove and the arrangement of the muscle scars in the ventral valve; the dorsal valve he compared with that of *Acrothele*. He said [1899, p. 6]: "The agreement goes so far that we may consider *Obolella crassa* [Walcott, 1886b, p. 114] and *Acrothele granulata* [Linnarsson, 1876, p. 24] as the extreme forms of *Mobergia*." The difference between the ventral valves of *Obolella crassa* (Hall) and *Botsfordia* is that in the latter the pedicle groove and area have disappeared and a narrow listrium takes the place of the area, the pedicle opening passing through the shell, while in *Obolella* the pedicle opening is above a clearly defined area. The dorsal valve of *Botsfordia* is more like that of *Acrothele*. The young shells of *Obolella* may have been provided with a pedicle opening in the young stages of growth, much like that in the adult stages of *Botsfordia*. *Botsfordia* appears to be a primitive form of Acrotretidæ to the extent that the false area of the ventral valve is only a thin band between the pedicle opening and the posterior margin, whereas in *Acrotreta* there is a well-developed false area. *Botsfordia* appears to represent the first, or, at least, an early stage between the open pedicle furrow of *Obolus* and the inclosed pedicle tube of *Acrothele* and *Acrotreta*. *Botsfordia* differs from *Acrothele* by the form of its visceral area and position of the main vascular sinuses in the ventral valve, also the position of the pedicle opening.

The cancellated surface of *Botsfordia pulchra* (Matthew) is similar to that of *Micromitra* (*Iphidella*) *pannula* (White) (compare Pl. LXII, figs. 5, 5a–c, with Pl. IV, figs. 1s, 1t). The forms of surface in *B. granulata* (Redlich) and *B. cælata* (Hall) are often found in species of *Obolus* (*Westonia*) and *Lingulella* (*Lingulepis*) (Pls. XLIV, XLVII). The surface of *Acrothele* (*Redlichella*) *granulata* (Linnarsson) (Pl. LVI) is similar to that of *Botsfordia granulata* (Redlich) (Pl. LVII). In *Schizopholis rugosa* Waagen the false cardinal area is more developed than in *Botsfordia*, and the apex is elevated. *Schizopholis* appears to be a form intermediate between *Botsfordia* and *Acrotreta*. At present the species of *Botsfordia* known to me are *B. pulchra* (Matthew), *B. cælata* (Hall), *B. granulata* (Redlich), and *B.? barrandei* Walcott.

Botsfordia? barrandei Walcott.

Plate LVII, figures 7, 7a–b.

Brachiopode nouv. gen. de Verneuil and Barrande, 1860, Bull. Soc. géol. France for 1859–1860, 2d ser., vol. 17, pp. 536–537, Pl. VIII, figs. 5, 5a–e. (Described and discussed in French as a new species. Figs. 5, 5a–b are copied in this monograph, Pl. LVII, figs. 7, 7a–b, respectively.)

Acrothele Pompeckj (in part), 1896, Jahrb. K.-k. geol. Reichsanstalt for 1895, Bd. 45, Hft. 3, p. 603. (Discussed in German, changing generic reference; see p. 603 for translation.)

Botsfordia? barrandei Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 77–78. (Discussion in the preceding reference translated and species described and discussed as on p. 603 as a new species.)

Of this species Pompeckj [1896b, p. 603] writes:

From Barrande's description and figure it is not quite easy to interpret this species. I have before me several specimens of a brachiopod from Coulouma, in the Department of Hérault, which Miquel [1893, p. 9] mentioned as "la *Discina*." I regard this south French form as belonging to the genus *Acrothele*, and believe that it is probably identical with the species mentioned by de Verneuil, Barrande, and Barrois as occurring in Spain.

Having before me the specimens which Miquel collected, and which I have named *Acrothele bergeroni* (Pl. LVIII), I do not think they can be considered the same as the form described by de Verneuil and Barrande. (Compare Pl. LVII, figs. 7, 7a–b with Pl. LVIII, figs. 6, 6a–c.)

From Barrande's description and illustration the following note is written: The shell is about as wide as long, suboval, with pointed beaks; valves moderately convex, with the ventral a little more so than the dorsal. There is a small area on each valve, but no trace of a triangular false deltidium. Beak of ventral valve with a minute pedicle opening. Surface with fine, distinct, concentric striæ. Substance of shell calcareous.

A shell 13 mm. in length has the same width, and the thickness of the two valves united is 5 mm.

Barrande thought that a new genus was indicated, but in the absence of interior characters decided not to name the genus or species. The perforate ventral valve and area suggested *Siphonotreta* to him, but the calcareous shell was opposed to it.

I have referred the shell to the genus *Botsfordia* provisionally and named it after Barrande, whose memory all paleontologists take pleasure in recalling.

The reference to *Botsfordia* is made on account of: (a) the subacuminate ventral valve with minute pedicle opening above a false cardinal area unmarked by a false deltidium; (b) the convex ventral and dorsal valve; (c) the tendency of *Botsfordia pulchra* Matthew to have the substance of its rather thick shell replaced by calcareous matter.

I have attempted to secure specimens of this shell, but unsuccessfully. Until further information can be secured the present reference will serve to indicate the probable relationship of the species.

Formation and locality.—**Middle Cambrian: (350** [de Verneuil and Barrande, 1860, p. 538]) Red limestone of the *Paradoxides* zone, near Adrados, north of Sabero and Boñar, Cantabrian Mountains, Province of Leon, northwestern Spain.

Botsfordia cælata (Hall).

Plate LIX, figures 1, 1a–q, 3, 3a–b.

Orbicula cælata Hall, 1847, Nat. Hist. New York, Paleontology, vol. 1, p. 290, Pl. LXXIX, figs. 9a–c. (Described and discussed as a new species.)

Obolella (*Orbicula*) *cælata* (Hall), Ford, 1871, Am. Jour. Sci., 3d ser., vol. 2, p. 33. (Merely changes generic reference.)

Obolella cælata (Hall), Billings, 1872, Canadian Naturalist, 2d ser., vol. 6, No. 2, p. 218. (Merely changes generic reference.)

Lingulella cælata (Hall), Ford, 1878, Am. Jour. Sci., 3d ser., vol. 15, pp. 127–128. (Described and discussed.)

Lingulella cælata (Hall), Walcott, 1886, Bull. U. S. Geol. Survey No. 30, p. 95, Pl. VII, figs. 1, 1a–d. (Copies the first paragraph of Hall, 1847, p. 290, copies Ford, 1878, pp. 127–128, and discusses species. The specimens represented by figs. 1b and 1d are redrawn in this monograph, Pl. LIX, figs. 1c and 1o, respectively.)

Lingulella cælata (Hall), Walcott, 1887, Am. Jour. Sci., 3d ser., vol. 34, p. 199, Pl. I, fig. 16, opposite p. 240. (The description of the plate is on p. 199.)

Lingulella cælata (Hall), Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 607, Pl. LXVII, figs. 1, 1a–e. (Localities mentioned. Figs. 1, 1a–d are copied from Walcott, 1886b, Pl. VII, figs. 1, 1a–d, respectively. Fig. 1e is copied from Walcott, 1887, Pl. I, fig. 16.)

Lingulella cælata (Hall), Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, Pl. III, figs. 1–4. (No text reference.)

Lingulella cælata (Hall), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 57 and 58, Pl. II, figs. 1–4. (Mentioned in the text. Figs. 1–4 are copied from figs. 1–4 of the preceding reference.)

Lingulella (*?*) *cælata* (Hall), Matthew, 1895, Trans. New York Acad. Sci. for 1894–95, vol. 14, p. 126. (Specimens from a new locality characterized and discussed.)

Obolus (*Lingulella*) *bicensis* Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 688. (Described and discussed as a new species.)

General form elongate ovate and varying from broad oval to oval acuminate. Ventral valve moderately convex with the longitudinal line nearly flat from a short distance in front of

the apex nearly to the front margin in old shells; in young shells it rises with a gentle slope from the front margin to the umbo; the posterior margin, including some distance along the cardinal slopes, rises and arches gently above the plane of the edges of the front and sides of the valve, which brings the apex or beak close to the posterior margin (Pl. LIX, fig. 1b); pedicle opening small and at the point of the apex or beak.

Dorsal valve more broadly ovate in outline than the ventral, moderately convex, and rather strongly arched toward the beak, which is marginal; the arching of the posterior portion of the valve causes it to fit closely into the upward arching posterior margin of the ventral valve; a shallow median sinus of varying strength and width extends from the umbo toward the front margin, where it usually disappears.

Surface highly ornamented by narrow, closely arranged, concentric, elevated, irregular, and often inosculating lines, on which small round pustules are lined in such a manner as to give a beaded effect to the surface. The width of the ridges and size of the pustules vary on shells from the same localities and from different localities. Often the shells have been worn by attrition so as to be almost smooth, the coarser striæ and lines of growth alone remaining; in addition some shells have more or less numerous, rounded, depressed, radiating ridges, which may be quite regular (Pl. LIX, fig. 1h) or very irregular and discontinuous (Pl. LIX, fig. 1c); some shells are without traces of the radiating ridges and others have only the faint outlines of them. The inner layers are usually shiny and marked by concentric lines and striæ, and numerous fine radiating striæ.

Shell substance corneous; shell rather thin when young, increasing to a rather strong shell in large specimens; it is built up of a rather thin outer layer and several inner layers or lamellæ. The largest ventral valve has a length of 10 mm., width of 8 mm., toward the anterior margin; as this shell has been broken near the beak and also at the anterior margin, it probably had a length of 12 to 13 mm.

The interior of the ventral valve shows strong main vascular sinuses, which originate near the pedicle opening, and gradually separate as they extend forward into the valve; beyond the center they curve slightly inward and terminate about the anterior fifth of the length of the valve. A small visceral area extends a short distance forward between the main vascular sinuses; it has a narrow depressed space across the front (Pl. LIX, fig. 1g) that indicates the position of the central, outside lateral, and middle lateral scars; the furrow that extends from near the center of the visceral area to the pedicle opening near the posterior margin is clearly indicated on figure 1e; as the pedicle opening was at the extreme end and with only a very narrow listrium between it and the posterior margin, the cast of it, or any trace of it, is very difficult to find; this is rendered doubly so by the thin posterior portion of the shell breaking off both before being embedded in the sediment and when being worked out of the rock. There may have been a narrow area, but it has not been seen, and nothing definite is known of the muscle scars.

The interior of the dorsal valve shows a short narrow area, from which a rather broad, low, median ridge extends forward beyond the center of the valve; a narrow septum is indicated along the posterior portion of the ridge; strong main vascular sinuses originate beside the median ridge at the back and diverge gradually as they extend into the valve; the position of the central and lateral muscle scars appears to have been the same as in *Obolus* (Pl. LIX, fig. 1 l), but they have not been clearly distinguished except one central scar (h); the cardinal muscle scars are large and situated outside of the main vascular sinuses about their own length in advance of the area.

Observations.—This species, like *Botsfordia granulata* (Redlich), is characterized by having the pedicle aperture close to the posterior margin; it also has the same *Obolus*-like arrangement of the visceral area, vascular sinuses, and muscle scars in the ventral valve; it differs in outline, surface, and interior markings from *B. granulata*.

When studying the genus *Lingulella* in 1898 I left *Lingulella cælata* (Hall) out of the list of species of *Lingulella* [Walcott, 1898b, p. 393], as I was satisfied that it did not belong there, but

it was not until the study of *Botsfordia* Matthew was taken up that a satisfactory generic reference was established.

The shell appears to have been easily broken, as it is very difficult to obtain good specimens, especially of the ventral valve. It was 10 years or more after I began collecting it before a ventral valve was found showing the pedicle opening. In 1901 I described a young shell of this species as *Obolus* (*Lingulella*) *bicensis* [Walcott, 1901, p. 688]. By comparison with other small shells from the type locality at Troy, New York, I am satisfied that the Bic specimen is a young shell of *B. cælata*.

Botsfordia cælata is widely distributed in the Lower Cambrian rocks of the St. Lawrence River, Lake Champlain, and Hudson River valleys, and it is one of the oldest of the Cambrian brachiopods of the Atlantic province of eastern North America.

At Troy, and in Washington County, New York, it is associated with the trilobites *Ellipto-cephala asaphoides* Emmons and *Conocoryphe trilineata* (Emmons) of the Lower Cambrian fauna, and in the Georgia, Vermont, section it is 700 feet lower than *Olenellus thompsoni* (Hall).

FORMATION AND LOCALITY.—**Middle Cambrian**: (**308e** [Matthew, 1895a, p. 126]) Beds of Division C1b1 of Matthew's [1895a, p. 108] *Protolenus* zone, on Hanford Brook, St. John County, New Brunswick.

Lower Cambrian: (**2o**) Limestone bowlders in conglomerate, on shore at east entrance to harbor at Bic; (**2r**) limestone bowlders in a conglomerate in a cut on the Intercolonial Railway, 2 miles (3.2 km.) west of Bic railway station; and (**2p**) limestone on south side of road a little west of Bic and half a mile (0.8 km.) west of the road leading to the wharf; all in Rimouski County, Quebec, Canada.

(**392c**) At the Straits of Belleisle, Labrador.

(**319j**) Sandstone 50 feet (15 m.) above the base of the section west of Parker's quarry and about a mile (1.6 km.) from the shore of Lake Champlain, in the township of Georgia, Franklin County, Vermont.

(**29a**) Limestone 1 mile (1.6 km.) below the New York Central Railroad depot at Schodack; (**2b**) limestone just north of Beman Park, in the northeastern part of the city of Troy, Troy quadrangle (U. S. Geol. Survey); (**367i** [*Hall, 1847, p. 290*]) *shales near Troy;* and (**27**) even-bedded and conglomerate limestones on the ridge in the eastern suburb of Troy, Troy quadrangle (U. S. Geol. Survey); all in Rensselaer County, New York.

(**33**) Limestone on the roadside near Rock Hill schoolhouse near North Greenwich, about 5 miles (8 km.) north-northeast of Greenwich; (**33b**) limestone on M. C. Tefft's farm, 1.5 miles (2.4 km.) east-southeast of North Greenwich, about 5 miles (8 km.) north-northeast of Greenwich; (**36b**) limestone near schoolhouse No. 12, near Greenwich; (**39a**) limestone 0.25 mile (0.4 km.) north of Easton Station, 3 miles (4.8 km.) south of Greenwich; and (**43a**) limestone 1 mile (1.6 km.) east-northeast of Salem; all in the Cambridge quadrangle (U. S. Geol. Survey), Washington County, New York.

(**34a**) Limestone 1 mile (1.6 km.) west of North Hebron, 5 miles (8 km.) south-southwest of Granville; (**38**) limestone 0.25 mile (0.4 km.) north of John Hulett's farmhouse about 3 miles (4.8 km.) west of South Granville and 4.5 miles (7.2 km.) southwest of Granville; and (**38a**) limestone 2 miles (3.2 km.) south of North Granville, on the road which turns south from the road running between that village and Truthville, 4 miles (6.4 km.) west-northwest of Granville; all in the Fort Ann quadrangle (U. S. Geol. Survey), Washington County, New York.

(**38c**) Shale at the slate quarries on the west side of the valley 1 mile (1.6 km.) north of Middle Granville, Mettawee quadrangle (U. S. Geol. Survey); (**34**) limestone on roadside a little west of the bridge over Poultney River at Low Hampton, about 5 miles (8 km.) east-northeast of Whitehall, Whitehall quadrangle (U. S. Geol. Survey); (**35**) Limestones 1.5 miles (2.4 km.) north of Bald Mountain and 3.5 miles (5.6 km.) north-northwest of Greenwich, Schuylerville quadrangle (U. S. Geol. Survey); (**35a**) shaly limestone on the west slope of the summit of Bald Mountain, 3 miles (4.8 km.) north-northwest of Greenwich, Schuylerville quadrangle (U. S. Geol. Survey); (**338h**) limestone on the summit of Bald Mountain, about 2 miles (3.2 km.) northwest of Greenwich, Schuylerville quadrangle (U. S. Geol. Survey); and (**39**) limestone south of the Delaware and Hudson railroad track, on the road running south-southwest from Low Hampton, about 5 miles (8 km.) east-northeast of Whitehall, Whitehall quadrangle (U. S. Geol. Survey); all in Washington County, New York.

BOTSFORDIA GRANULATA (Redlich).

Plate LVII, figures 4, 4a–r.

Mobergia granulata REDLICH, 1899, Mem. Geol. Survey India, Paleontologia Indica, new ser., vol. 1, No. 1: The Cambrian fauna of the Eastern Salt Range, pp. 5–6, Pl. I, figs. 11–18. (The description and discussion of this new species is incorporated with that of the new genus "*Mobergia.*")

General form subcircular, with the ventral valve very obtusely acuminate, and the dorsal valve transversely more or less broadly oval. Ventral valve moderately convex with the

longitudinal line nearly flat from the apex to beyond the center of the valve, where it slopes gently to the anterior margin; on some shells the slope to the apex rises more abruptly and there is a gentle slope from the umbo to the front margin; the posterior margin arches gently upward from the plane of the edges of the front and sides of the valve. Apex directed backward and perforated by a minute pedicle opening; it extends a little beyond the posterior margin, and is separated from it by a narrow false area or rim of shell; on some shells an elongate, more or less crescentiform tubercle occurs on each side of the apex, and just back of them at the end of the depression between them the minute pedicle opening occurs, or there may be a thickening of the shell back of the opening which results in a tubercle, as shown in Plate LVII, figure 4d; in other shells there is simply a thickened rim of shell about the front and sides of the apex with the pedicle opening at the posterior section of it (Pl. LVII, fig. 4c). Dorsal valve moderately convex; it slopes rather abruptly from the umbo to the minute marginal beak and gently to the front; a minute tubercle occurs on each side of the beak of perfect specimens (Pl. LVII, fig. 4b).

Surface marked by concentric lines of growth and low, rounded, more or less obscure radiating ridges that occur on the anterolateral portions, or on the central part, or all across in front of the umbo and sides, or only as faint traces; in addition there is a system of fine undulating, irregular, more or less inosculating, concentric ridges, upon which there are minute rounded tubercles or granules that have no extended systematic arrangement; on some shells the granulated surface extends to the front margin and on others more or less of the front portion of the valves is marked only by concentric lines and traces of the undulating ridges; in some places the granules are arranged in diagonal lines that cross each other obliquely, and then the effect is a modified form of the surface of *Botsfordia pulchra* (Matthew).

The following are measurements of the valves:

Dimensions of valves of Botsfordia granulata (Redlich).

	Length. mm.	Width. mm.
Ventral	6.5	7.5
Ventral	6.5	6.5
Dorsal	4	5
Dorsal	4.5	5

The specimens are embedded in a fine shale and are more or less flattened by compression.

The shells are built up of a thin outer layer and several inner layers or lamellæ slightly oblique to the outer surface. The shell substance is corneous or, according to the author, "phosphate of lime and chitine" [Redlich, 1899, p. 6].

The interior of the ventral valve is essentially the same as that of *Botsfordia pulchra* (Matthew) and *B. cælata* (Hall); strong main vascular sinuses rise beside the median line close to the posterior margin and gradually diverging, extend forward into the body of the valve nearer to the median line than to the outer margins; the visceral area is about three-eighths the length of the valve and it has a narrow median groove that terminates in a club-shaped anterior end (Pl. LVII, fig. 4g) that suggests the heart-shaped cavity of *Obolus* (Pl. VII, figs. 1, 3, and 6). The position of the transmedian and anterior lateral muscle scars is shown close beside the main vascular sinus; the central scars and outside and middle laterals can not be separated but the space they occupy is indicated at c, Plate LVII, figure 4p. The cast of the pedicle passage through the shell is shown in figure 4i.

The interior of the ventral valve is much like that of *Acrothele coriacea* Linnarsson. (Compare Pl. LVII, fig. 4k, with Pl. LVI, fig. 1e.) There is a median ridge with the main vascular sinuses starting out beside it near the posterior margin and gradually separating as they extend forward into the valve about halfway between the margins of the valve and the median ridge; the cardinal muscle scars are small and close to the median ridge, posterior margin, and main vascular sinuses; the central muscle scars occur on the slope of the median ridge a little back of the center of the valve, and the small anterior laterals close to the median line a little in advance; in young shells the transmedian and middle and outside laterals are combined in

one scar (cl, Pl. LVII, fig. 4k), but in a larger shell the transmedian scars are separated back of the middle and outside lateral scars, which can not be distinguished as separate scars.

Observations.—Redlich [1899, p. 5] proposed the genus "*Mobergia*" for this species. This was well done, but Matthew [1891, p. 148] had previously described *Botsfordia*. *Botsfordia granulata* (Redlich) has the same type of interior in both valves as *B. pulchra* (Matthew), and the granulated surface is of the same general type except that it is more completely developed in *B. pulchra*. There is a strong generic relation to *Botsfordia cælata* (Hall) but the specific differences are very decided.

Doctor Holland, director of the Geological Survey of India, kindly sent me the type specimens of this species, and through the courtesy of Dr. Fritz Noetling, I obtained for the United States National Museum a fine collection of this species from the Salt Range.

FORMATION AND LOCALITY.—**Middle Cambrian**: (15r)[a] Dark argillaceous shales, at Khussak, Salt Range, India.

BOTSFORDIA PULCHRA (Matthew).

Plate LXII, figures 5, 5a–l.

Lingulella (?) cf. *Lingula favosa* Linnarsson, MATTHEW, 1888, Canadian Rec. Sci., vol. 3, No. 1, pp. 28–29. (Mentioned.)

Obolus pulcher MATTHEW, 1889, idem, vol. 3, pp. 306–307, figs. 1–8, p. 306. (Described and discussed as a new species.)

Obolus pulcher MATTHEW, 1890, Trans. Roy. Soc. Canada for 1889, 1st ser., vol. 7, sec. 4, No. 12, pp. 151–155, Pl. VIII, figs. 1a–m, 2a–l. (Description given by Matthew, 1889, pp. 306–307, copied, and species described and discussed in great detail. Figs. 1a–c and 2a–c are copied from figs. 3–8, respectively, of the preceding reference.)

Obolus (*Botsfordia*) *pulcher* MATTHEW, 1891, idem for 1890, vol. 8, sec. 4, No. 6, p. 148. (Mentioned.)

Obolus (*Botsfordia*) *pulcher* MATTHEW, 1892, idem for 1891, vol. 9, sec. 4, No. 5, pp. 62–63. (Discussed, the new subgeneric name being proposed on page 63.)

Obolus? pulcher Matthew, HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 81, Pl. IV K, fig. 22. (Characterized, questioning generic reference.)

Obolus? pulcher Matthew, HALL and CLARKE, 1892, idem, p. 183. (Characterized and discussed, copying Matthew's notes, 1890, p. 154, on the stages of growth and development. Calls attention to resemblance of this species, in growth stages, to *Kutorgina*.)

Obolus (*Botsfordia*) *pulchra* MATTHEW, 1894, Trans. Roy. Soc. Canada for 1893, 1st ser., vol. 11, sec. 4, No. 8, pp. 90–91, Pl. XVI, figs. 3 and 3b. (Described and discussed.)

Obolus (*Botsfordia*) *pulchra* MATTHEW, 1895, Trans. New York Acad. Sci. for 1894–95, vol. 14, pp. 115–121, Pl. III, figs. 1a–i, 1k, 2a–g, 2i, and 2k (the missing figures are lacking in the reference; they have not been referred elsewhere in this monograph). (With the exception of the note on the horizon in the first paragraph, the text is copied from Matthew, 1890, pp. 151–155. Figs. 1a–i, 2a–g, and 2i are copied from Matthew, 1890, Pl. VIII, figs. 1a–i, 2a–g, and 2i, respectively. Figs. 1k and 2k are copied from Matthew, 1894, Pl. XVI, figs. 3b and 3, respectively.)

Obolus (*Botsfordia*) *pulcher* MATTHEW, 1902, Trans. Roy. Soc. Canada for 1902, 2d ser., vol. 8, sec. 4, No. 3, p. 95, Pl. I, figs. 7a–b. (Characterized and discussed.)

General outline subcircular; the ventral valve being obtusely acuminate and the dorsal a little wider than long. Ventral valve gently convex, most elevated at or a little in front of the apex; apex close to the posterior margin and pointed backward; there is a minute pedicle aperture at the end of the apex. The posterior margin of the valve is arched upward so as to leave only a narrow rim between the margin and the pedicle aperture. Dorsal valve moderately convex, more arched toward the front in old shells, and in all shells it arches upward at the posterior margin so as to fit closely against the margin of the ventral valve.

Surface marked by concentric lines of growth that form imbricating ridges at irregular intervals. In addition there is a reticulated surface formed by the presence on the rounded concentric ridges of small tubercles that are rounded quadrilateral in outline and that alternate on the adjacent ridges, so that each tubercle falls opposite the space between the two tubercles in front; this results in rows of tubercles that are apparently arranged in oblique rows extending from the posterolateral margin of the shell on each side obliquely forward to the margin of the shell on the opposite side; the depressions between the tubercles unite and serve to increase the appearance of an oblique reticulate, tuberculated surface; the tubercles are low at the back and high in front. The finely cancellated surface is usually on the posterior half of the shell, the tubercles becoming scattered and often entirely absent over

[a] Specimens from the type locality were given to the United States National Museum and this number was assigned to them.

the anterior and lateral portion of the valves. The interior layers and interior surface show numerous fine, radiating striæ, and there are also a few radiating lines on the anterior portion of the adult shells.

The shell is built up of a thin outer layer and numerous inner layers or lamellæ that are oblique to the outer surface; the oblique layers on the front portion and sides of adult shells terminate at the growth lines, so as to give an imbricated appearance to the surface. Shell substance apparently corneous.

A large ventral valve has a length and breadth of 11.5 mm. A dorsal valve 10 mm. long has a width of 12 mm. These proportions vary slightly in different shells.

The interior of the adult ventral valve is much like that of *Botsfordia cælata* (Hall). It has a short visceral area between distinctly marked main vascular sinuses that originate one on each side of the median line at the posterior margin, and gradually separate as they extend forward into the valve; no distinct muscle scars have been seen in this valve. The interior of the dorsal valve has a long central ridge extending well toward the front of the valve; at about the center it shows a tendency to bifurcate; the main vascular sinuses originate at the median line near the posterior margin and arch rapidly outward on each side and then obliquely forward into the body of the valve; the muscle scars are represented by an elongate cardinal scar on each side near the main vascular sinus, where it curves forward into the valve; also one central muscle scar on each side of the median ridge a little back of the center of the valve.

Under the description of the genus *Botsfordia* I have referred (p. 602) to the description of the interior of this species by Matthew. I have given above all I can observe on the specimens in the Matthew collection now at the University of Toronto, also on the specimens in the collection of the United States National Museum.

Observations.—This species is so clearly distinct from *Botsfordia cælata* (Hall) and *B. granulata* (Redlich) that comparison is unnecessary. It agrees with both of the latter species in having the perforated apex of the ventral valve separated from the posterior margin by a narrow rim of shell, also in having a short visceral area and strong main vascular sinuses. The dorsal valves are of the same general type.

Formation and locality.—**Middle Cambrian:** (2y) Sandstone about 25 feet (7.6 m.) above the Lower Cambrian, on the southeast side of Catons Island; and (308d [*Matthew, 1894, p. 121*]) *sandstones of Division C1b2–4 of Matthew's section on Catons Island;* both in Long Reach, St. John River, Kings County, New Brunswick.

Genus SCHIZOPHOLIS Waagen.

[$\sigma\chi\acute{\iota}\zeta\omega$, I divide; and $\phi o\lambda\acute{\iota}\varsigma$, a scale.]

Schizopholis Waagen, 1885, Mem. Geol. Survey India, Paleontologia Indica, 13th ser., Salt Range Fossils, vol. 1, pt. 1, p. 752. (Described as a new genus.)

Schizopholis Waagen, Oehlert, 1887, Manuel de conchyliologie, by Fischer, p. 1267. (Described in French, with figures of *S. rugosa*.)

Schizopholis Waagen, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 248. (Described.)

Schizopholis Waagen, Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, p. 564. (Copy of preceding reference.)

Schizopholis Waagen, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 94. (Copies original description and discusses genus.)

Schizopholis Waagen, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 145. (Classification of genus.)

Revised generic description.—Ventral valve slightly conical with eccentric apex perforated on the posterior side by a minute foramen. On the posterior slope beneath the apex there is a slightly flattened false area across which the striæ of growth of the shell appear. The striæ arch upward near the center and form a narrow false deltidium, very much as in the genera *Acrothele* and *Acrotreta*. The pedicle opening occurs at the apex of the false deltidium and penetrates the apex of the shell. Dorsal valve nearly flat, umbo slightly elevated, beak marginal.

Surface of shell marked by fine concentric lines and striæ of growth, and irregular, interrupted, slightly elevated, radiating ridges which give a rugose appearance to the surface. Shell substance calcareocorneous. Shell built up of several layers or lamellæ.

Type.—Schizopholis rugosa Waagen.

Observations.—The generic relations of this shell, as far as can now be determined, are with *Acrothele*. With our present information it differs only in its more marked false deltidium.

The interior of a dorsal valve from the same bed of sandstone is tentatively referred to this species (Pl. I, fig. 4c). The area of the valve is narrow and not clearly defined; it appears to be merged into a small projecting platform that extends in front into a strong median ridge; at each side of the ridge the platform-like area overhangs a little so as to form a slight hollow beneath; the median ridge extends nearly to the front margin of the shell, very much as in the dorsal valve of *Acrotreta sagittalis* (Salter) (Pl. LXXI, fig. 3g).

My interpretation of this shell differs somewhat from that of Waagen [1885, p. 752]. This arises from his thinking that the false deltidium was an open fissure. On cleaning away the dirt I find that there is a depressed triangular space and that the lines and striæ of growth cross the false area and the false deltidium; also that the foraminal opening is a simple circular aperture as in *Acrothele*.

Schizopholis rugosa Waagen.

Plate I, figure 4c; Plate LXXXI, figures 1, 1a–c.

Schizopholis rugosa Waagen, 1885, Mem. Geol. Survey India, Paleontologia Indica, 13th ser., Salt Range Fossils, vol. 1, pt. 1, pp. 753–754, Pl. LXXXVI, figs. 2–4. (Described and discussed as a new species. The specimens represented by figs. 3 and 4 are redrawn in this monograph, Pl. LXXXI, figs. 1c and 1, 1a–b, respectively.)

Schizopholis rugosa Waagen, 1891, idem, vol. 4, pt. 2, Pl. II, figs. 12–14. (No text reference. With the exception of fig. 4c, which is not copied in 1891, figs. 13, 14, and 12 are copied from figs. 2–4, respectively, of the preceding reference.)

Schizopholis rugosa Waagen, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 248, figs. 259 and 260. (No text reference. Figs. 259 and 260 are copied from Waagen, 1885, Pl. LXXXVI, figs. 4d and 4b, respectively.)

Schizopholis rugosa Waagen, Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, p. 564, figs. 259 and 260. (Copy of preceding reference.)

Schizopholis rugosa Waagen, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 95, figs. 50 and 51. (Mentioned in discussion of genus *Schizopholis*. Figs. 50 and 51 are copied from Waagen, 1885, Pl. LXXXVI, figs. 4d and 4b, respectively.)

General form ovate. Ventral valve slightly convex, greatest elevation at the apex, which is nearly above the posterior margin; apex minute and perforated by a circular opening. The posterior side of the shell beneath the apex is slightly flattened so as to form a false area, divided midway by a false deltidium formed by the arching of the lines and striæ of growth; an angle is formed at the point where the lines and striæ arch upward, which gives form to the slight depression, or the false deltidium. Dorsal valve nearly flat, except near the umbo, which is slightly elevated, apex marginal, minute.

Surface marked by numerous concentric lines and striæ of growth, and irregular, interrupted, slightly elevated, radiating ridges that vary in size and direction on different shells. The shell is thin on the edges, becoming thicker toward the umbonal portions by the addition of thin layers or lamellæ. The type specimen of the ventral valve has a length and width of 6 mm.

Observations.—This species is allied to *Botsfordia cælata* (Hall). It differs in surface characters, general outline, and the presence of a false deltidium and area.

Formation and locality.—**Middle Cambrian:** (**357c** [Waagen, 1885, p. 754]) Lower portion of the "*Neobolus* beds" of the Khussak group, in purplish-colored, fine-grained, micaceous sandstone, near the fresh-water springs in a gorge above the salt mines at Kiura (Khewra), Salt Range, India.

Genus QUEBECIA Walcott.[a]

Quebecia Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 320. (Mentioned as on p. 610 as a new genus.)

Quebecia Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 145. (Classification of genus.)

[a] The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Quebecia* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following generic references are listed:

Obolella Billings [1872a, p. 219; 1872c, p. 357].

Obolella Walcott [1886b, p. 118; 1891a, p. 611].

The description of the species includes that of the genus, as there is only one species now known.

Type.—Obolella circe Billings.

The generic name is derived from the city of Quebec, near which the type species occurs.

Quebecia circe (Billings).

Plate CIV, figures 7, 7a–g.

Obolella circe Billings, 1872, Canadian Naturalist, 2d ser., vol. 6, No. 2, pp. 219–220. (Described and discussed as a new species.)

Obolella circe Billings, 1872, Am. Jour. Sci., 3d ser., vol. 3, pp. 357–358. (Copy of preceding reference.)

Obolella circe Billings, Walcott (in part), 1886, Bull. U. S. Geol. Survey No. 30, p. 118, Pl. X, fig. 3a (not fig. 3). (Original description, Billings, 1872a, pp. 219–220, copied. The specimen represented by fig. 3a is redrawn in this monograph, Pl. CIV, fig. 7e. Fig. 3 represents a specimen of *Obolella chromatica*.)

Obolella circe Billings, Walcott (in part), 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 611, Pl. LXXI, fig. 3a (not fig. 3). (Mentioned. Fig. 3a is copied from Walcott, 1886b, Pl. X, fig. 3a. Fig. 3 represents a specimen of *Obolella chromatica*.)

Billingsella circe (Billings), Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 673. (Merely changes generic reference.)

Quebecia circe (Billings), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 320–321. (Described and discussed essentially as below.)

General form broad ovate, with front and sides uniformly rounded, planoconvex. Surface marked by fine concentric striæ of growth. A ventral valve 3.5 mm. in length has a width of 4.5 mm. A dorsal valve 4.5 mm. in length has the same width; a larger dorsal valve, 11 mm. in length, has a width of 10.5 mm. Shell rather thick, and composed of calcite in its present condition.

The ventral valve has an elevated umbo terminating in a sharp upward-pointing apex that may be perforate; from the umbo the surface, in young shells, slopes so rapidly that the central and outer portions of the shell are nearly flat, but in older shells moderately convex; area short and divided midway by a relatively broad delthyrium that is nearly covered by a convex deltidium; the inner surface is marked by fine, elevated, rather widely separated, radiating striæ and very fine punctæ; the very broad main vascular sinuses arch forward from a point beneath the umbo and inclose a small, slightly elevated visceral area; a strong cardinal tubercle occurs on each side of the pseudo-area (cl, Pl. CIV, figs. 7a and 7b) which was probably the point of attachment of the cardinal muscle, i. e., transmedian and anterior laterals.

Dorsal valve gently convex in young shells, becoming strongly convex in old shells; no traces of an area have been observed—if present it must have been short and very low, as the beak is nearly at the plane of the margins of the shell; casts of the interior show that the valve was thickened beneath the umbo by a ridge that separated what may be called the umbonal cavity from the main cavity of the valve. On the cast of an old shell a rounded, narrow, longitudinal, median ridge divides the umbonal cavity; on each side of the cavity and beyond it there is the strongly marked path of advance of the transmedian muscle scars; in front of the transverse ridge two strong ridges that extend toward the center of the valve occupy the position of the main vascular trunks; in one specimen a narrow groove extends from the central muscle scar along the inside margin of the ridge (Pl. CIV, fig. 7).

The muscle scars now known are the transmedians and centrals; the former are situated close to the margin of the valve, and the space assigned them may also include the posterior laterals; the central scars are well indicated in several specimens, but no trace has been found of the anterolaterals. The cardinal tubercle (cl) includes the space that was occupied by the several points of attachment of the posterior muscle, i. e., transmedian, outside lateral, and middle laterals; the cast of the tubercle is an elongate depression just inside the margin of the shell.

Observations.—By incorrect interpretation, both Mr. Billings [1872a, p. 220] and myself [1886b, p. 118] identified the dorsal valve of the species as the ventral, and I illustrated [1886b, Pl. X, fig. 3] a dorsal valve of *Obolella chromatica* as the dorsal valve of "*O. circe*." When

studying some material representing the species in the collections of the United States National Museum I noticed the edge of a shell that, on working it free from the matrix, proved to be a ventral valve; two dorsal valves occur on the same bit of rock. Subsequently Dr. J. F. Whiteaves sent me a tablet from the collections of the Geological Survey of Canada, on which six specimens were labeled "*Obolella circe*." No. 1 is a cast of the interior of the dorsal valve of *Obolella crassa* (Hall), and No. 2 the exterior of the same species. Nos. 3 and 6 are ventral valves of *Quebecia circe*, and Nos. 4 and 5 dorsal valves.

With the ventral valve identified, it appeared that the shell was not an *Obolella*, but the type of an undescribed genus in which the ventral valve is elevated at the apex, with strong cardinal tubercles for the attachment of the posterior muscle scars, very much as in *Acrotreta*, and *Quebecia* was proposed. The cardinal tubercles and the presence of what appears to be the base of the cast of a foraminal tube suggest that the ventral valve was perforate. *Obolella*, *Quebecia*, and *Yorkia* are all strong, calcareous, perforate shells of the older Cambrian fauna, and are evidently closely related.

Formation and locality.—**Lower Cambrian:** (**3191** [*Billings, 1872a, p. 220*])[a] *Limestone bowlders in conglomerate at Trois Pistoles, on St. Lawrence River, below Quebec, Canada.*

(**392c** [Billings, 1872a, p. 218]) at the Straits of Belleisle, Labrador.

Family SIPHONOTRETIDÆ Kutorga.

Genus YORKIA Walcott.

Yorkia Walcott, 1897, Proc. U. S. Nat. Mus., vol. 19, p. 714. (Described and discussed as below as a new genus.)
Yorkia Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 146. (Classification of genus.)

Shell inarticulate, subcircular to suborbicular in outline. Apex of ventral valve perforate, marginal, with a false area and a pseudodeltidium. The cast of the interior of the valve shows a foramen which penetrated obliquely upward and backward through the thick umbonal portion of the shell. Two narrow furrows converge from the side of the pedicle opening toward the longitudinal mesial depression and then diverge toward the anterolateral portions of the shell.

The dorsal valve has a well-defined area and an obscure pseudodeltidium. The interior of this valve has a pair of broad, diverging, shear-shaped furrows passing directly forward from the beak for a short distance and then diverging to the outer margin, but not sufficiently to affect the outward curve of the inner margin.

Shell substance probably calcareous. External surface marked with more or less prominent concentric striæ and lines of growth.

Type.—*Yorkia wanneri* Walcott.

Observations.—The area and pseudodeltidium of the ventral valve resemble the same parts in *Trematobolus insignis* Matthew, but the pedicle opening is quite different, and generally the interior of the dorsal valves also serves to distinguish the forms. To *Discinopsis* Matthew there is a resemblance in the markings of the interior of the dorsal valve. *Discinopsis*, however, is founded upon a small, apparently corneous shell, which, so far as known, has no area or pseudodeltidium, and it is closely related to *Acrothele*. *Yorkia* differs from *Acrothele* in its pronounced area, substance of shell, and place of origin of vascular trunks. I do not know of any other genus of the Siphonotretidæ with which it can be compared.

The generic name is derived from York, Pennsylvania, near which the type species occurs.

Yorkia? miqueli n. sp.

Plate LXXXII, figure 4.

This species is represented by specimens of the ventral valve, that are compressed in arenaceous shale, and distorted dorsal valves. The ventral valve is small, 2 to 4 mm. in diameter; subcircular to transversely oval in outline, with the highest point at the apex,

[a] Specimens from this locality are included in the collections of the United States National Museum.

which is truncated by a circular opening; posterior slope unknown. Surface, as preserved in the arenaceous shale, marked by concentric striæ and lines of growth and obscure, very fine, radiating striæ. The substance of the shell appears to be corneous, and to make up several very thin lamellæ that combined make a thin shell.

The generic reference is doubtful, owing to the corneous, shiny character of the shell. This species and *Yorkia? washingtonensis* Walcott may belong to a new genus or a subgenus of *Yorkia*.

The specific name is given in honor of Mr. J. Miquel, of Barroubio, France.

FORMATION AND LOCALITY.—**Passage beds** between Cambrian and Ordovician, or Lower Ordovician: (**342a**) Barren quartzitic beds, Coulouma, Department of Hérault, France.

YORKIA? ORIENTALIS Walcott.

Plate LXXXII, figures 3, 3a.

Yorkia? orientalis WALCOTT, 1906, Proc. U. S. Nat. Mus., vol. 30, pp. 569–570. (Described and discussed as below as a new species.)

This species is represented by a single small ventral valve, which has the external characteristics of *Yorkia wanneri* Walcott, of the Lower Cambrian. The outline of the valve is transversely and broadly oval in outline exclusive of the apex rising above the posterior margin; the apex gives a subtriangular outline to the valve when looking down upon it; the apex is moderately elevated and projects over the posterior margin; it is perforated by a rather large aperture just above a small false area.

The surface of the valve is marked by low, rather broad, concentric undulations, a few fine, concentric striæ, and a very fine reticulate ornamentation formed by the crossing of oblique, elevated, curved lines, which form slightly elongate diamond-shaped pits between them. Shell substance apparently calcareous. Width of ventral valve, 2.5 mm.; length, 2 mm. at aperture, 2.25 at apex; elevation, 0.5 to 0.75 mm.

Observations.—As far as may be determined by the exterior of the valve, this species is properly referred to *Yorkia*. The generic reference, however, will remain in doubt until information is available as to the characters of the interior of the valve.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**C71**) Massive cliff-forming limestone in the central portion of Kichou formation [Willis and Blackwelder, 1907, pp. 139 and 145 (2d list of fossils)], 4 miles (6.4 km.) south-southwest of Tungyu, Shansi, China.

YORKIA WANNERI Walcott.

Plate LXXXII, figures 1, 1a–i.

Yorkia wanneri WALCOTT, 1897, Proc. U. S. Nat. Mus., vol. 19, p. 715, Pl. LX, figs. 1, 1a–e. (Described and discussed as below as a new species. The specimens represented by figs. 1, 1a–e are redrawn in this monograph, Pl. LXXXII, figs. 1a, 1c, 1g, 1h, and 1i, respectively; figs. 1b and 1c of the original reference (Pl. LX) being both drawn from the specimen represented in fig. 1g of Pl. LXXXII of this monograph.)

Shell subcircular to suborbicular in outline, moderately convex, with the apices of the valves marginal. Ventral valve highest at the beak, which is truncated by a circular foraminal opening; cardinal slope angular and slightly incurved, so as to form a narrow false area on each side of the slightly convex, rather broad pseudodeltidium. Numerous casts show the pseudodeltidium, false area, and a large filling or cast of the foramen which extended obliquely backward through the thickened umbonal portion of the shell to the apex. On a cast of the interior of the valve there are two elongated muscular or vascular (probably the latter) impressions that extend from the anterolateral base of the foraminal opening inward nearly to the median line, and then diagonally outward toward the anterior lateral margin of the shell. There is also a slight median longitudinal ridge that corresponds to a depression in the interior of the shell (Pl. LXXXII, figs. 1b and 1c). In other casts striæ or lines only are shown

radiating outward from the base of the foramen. Fine transverse striæ cross the narrow area and then incurve and cross the pseudodeltidium.

The dorsal valve has a well-defined area, with an obscure pseudodeltidium parting it midway. The cast of the interior of the valve shows two broad, shear-shaped diverging ridges that extend from near the apex to the center of the shell. Numerous vascular markings extend outward from the ridges. These ridges may indicate the muscular scars or merely the main trunks of the vascular depressions. The surface of the area is marked by fine transverse striæ that abruptly incurve toward the front of the area, so as to follow along its anterior margin to the pseudodeltidium.

The surfaces of both valves, as shown in the casts, are smooth, except where marked by concentric lines of growth.

Shell substance unknown, but probably calcareous. It is dissolved away in all the specimens in the collection, only the impression of the shell remaining in the decomposed arenaceous limestone.

This species occurs in abundance, associated with *Nisusia festinata*, *Hyolithes americanus*, and fragments of *Olenellus*.

The specific name was given in honor of Mr. Atreus Wanner.

FORMATION AND LOCALITY.—**Lower Cambrian**: (**49**) *Sandstone on Codorus Creek 0.125 mile (0.2 km.) below Meyer's mill, near Emigsville;* and (**49a**) sandstone on the Liverpool road, south of the schoolhouse, 3 miles (4.8 km.) northwest of York; both in York County, Pennsylvania.

Specimens that are somewhat doubtfully referred to this species occur at the following localities:

Lower Cambrian: (**2o**) Limestone bowlders in conglomerate, on shore at east entrance to harbor at Bic, Rimouski County, Quebec.

(**7**) Shaly beds about 1,000 feet (305 m.) above the quartzitic beds, Silver Canyon, White Mountain Range, Inyo County, California.

YORKIA? WASHINGTONENSIS Walcott.

Plate LXXXII, figures 2, 2a.

Yorkia? washingtonensis WALCOTT, 1897, Proc. U. S. Nat. Mus., vol. 19, pp. 715–716, Pl. LX, fig. 3. (Described and discussed as below as a new species. The specimen represented by fig. 3 is redrawn in this monograph, Pl. LXXXII, fig. 2.)

Ventral valve longitudinally ovate, depressed, convex. Area and pseudodeltidium invisible, but, from the character of the foramen and its resemblance to the foramen of *Y. wanneri*, it is probable that the area was somewhat similar to the area of that species. The cast of the interior of the ventral valve shows a rather long, large foramen, in advance of which two ridges (vascular trunks) diverge somewhat as in the ventral valve of *Y. wanneri* Walcott (p. 612). There is also present a short longitudinal depression in the cast, which indicates a corresponding mesial ridge just in advance of the foramen. The surface of the interior of the shell is marked by fine concentric lines and very fine interior ridges. Shell substance apparently corneous.

This species is founded upon two partial casts of the ventral valve, preserved in compact gray limestone. The shell appears to be very thin over the outer portions and thick over the umbonal region.

The generic reference is somewhat doubtful. *Obolella* is suggested by the cast of the pedicle tube, also *Trematobolus*. The pedicle tube and form of the vascular trunks suggest *Yorkia*, while the shell substance is more like that of *Botsfordia*.

The specific name is derived from Washington County, New York.

FORMATION AND LOCALITY.—**Lower Cambrian**: (**37b**) *Limestone 0.25 mile (0.4 km.) east of Salem, Cambridge quadrangle (U. S. Geol. Survey), Washington County;* (**338n**) western belt of conglomeratic limestone, Rensselaer County; and (**38a**) limestone 2 miles (3.2 km.) south of North Granville, on the road which turns south from the road running between that village and Truthville, 4 miles (6.4 km.) west-northwest of Granville, Fort Ann quadrangle (U. S. Geol. Survey), Washington County; all in New York.

Genus DEARBORNIA Walcott.

Dearbornia Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 78. (Mentioned as below as a new genus.)
Dearbornia Walcott, 1908, idem, vol. 53, No. 4, Pl. XI, and pp. 142 and 146. (Classification of genus.)

This genus is based on one species, which is well represented by fourteen specimens. The generic description is incorporated with the description of the type species.

Type.—Dearbornia clarki Walcott.

The generic name is taken from Mount Dearborn, named after Gen. Henry Dearborn, near which the type specimens were collected.

Dearbornia clarki Walcott.

Plate LXXXII, figures 7, 7a–d.

Dearbornia clarki Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 78–80, Pl. VIII, fig. 7. (Described and discussed as below as a new species. Fig. 7 is copied in this monograph, Pl. LXXXII, fig. 7.)

Shell subequivalve, subcircular in outline, slightly convex. Ventral valve most elevated at the pedicle aperture, which is circular, rather large, and situated from one-fifth to one-sixth the length of the valve from the posterior margin; the slope back of the foramen is gently rounded and without a trace of false area or pedicle groove; the position of the beak is not clearly defined, as the margin is rounded and the uniform slope of the outer surface is unbroken. Dorsal valve uniformly and slightly convex; the position of the beak is indicated by a slight projection of the outline of the valve.

Surface marked by fine concentric lines. The substance of the shell is calcareous in an oolitic limestone in which semiphosphatic shells of *Obolus* are preserved. The shell is thick and apparently formed of one layer, but this is probably, as in the case of the shells of *Obolella crassa* (Hall), a condition of preservation, the original layers or lamellæ having been replaced or else cemented together. The average size of the valves is from 3 to 5 mm.

The interior of the ventral valve does not show a true area; there is a space between the margin and the end of the median furrow, into which the foramen opens. The median furrow is rather broad and deepest at the foramen; it extends forward beyond the center of the valve; the furrow into which the foramen opens is broadest at the posterior end, and runs out to a point a little in advance of the opening; from each side of the furrow and opposite the opening a furrow extends obliquely outward and then forward subparallel to the median furrow. Two large, oval muscle scars occur in the space between the outer furrow and the posterolateral margin of the shell; these scars correspond in position to the transmedian and anterior lateral muscle scars of *Obolus* and *Trematobolus*. Nothing is clearly shown of the position of the main vascular canals unless the grooves outside of the median depression indicate their position, or it may be that they were on the narrow ridges outside of the side furrows and inside of the lateral muscle scars.

The interior of the dorsal valve shows a rudimentary area much like that of *Rustella edsoni* Walcott (Pl. I, fig. 1c); the area is a smooth space, with a slightly defined central depression from which a narrow, low median septum extends forward to about the center of the valve; a narrow ridge extends forward from the posterior central depression on each side at about the inner third of the distance between the median septum and the outer margin; these ridges probably marked the position of the main vascular sinuses. The central muscle scars (h) occur in the shallow depression on each side of the median septum, a little back of the transverse center of the valve, and the transmedian scars and outside laterals are just outside of the narrow ridges on each side of the valve; these scars, like those in the ventral valve, are large for so small a shell.

Observations.—Dearbornia clarki is one of the simple or rudimentary forms of Siphonotretidæ. It differs from *Siphonotreta* in the absence of an area and a siphonal or pedicle tube, in having the pedicle opening on the umbo in advance of the beak, and in its calcareous shell. The circular pedicle aperture without an exterior furrow, the absence of a well-defined area on the ventral valve, and its calcareous shell distinguish it from *Trematobolus* and *Schizambon.* The form and position of the pedicle opening suggest *Discinopsis*, but the interiors of the valves

are very dissimilar in the two genera. It may be that with the discovery of good exteriors of the ventral valve of *Trematobolus excelsis* Walcott that species will be found to have a circular pedicle opening of the same character as that of *Dearbornia clarki*, but from the similarity of the cast of the interior of the ventral valve of the former species to that of *Trematobolus kempanum* (Matthew) it is referred to *Trematobolus*.

The specific name is given in recognition of Dr. William B. Clark's work on the paleontology of Maryland.

FORMATION AND LOCALITY.—**Middle Cambrian: (9k)** Limestone forming 1c of the Dearborn River section [Walcott, 1908f, p. 201], on North Fork of Dearborn River, in the eastern part of the Lewis and Clark National Forest, Lewis and Clark County, Montana.

Genus TREMATOBOLUS Matthew.[a]

[τρῆμα, perforation; and Obolus.]

Trematobolus MATTHEW, 1893, Canadian Rec. Sci., vol. 5, pp. 276–279. (The species *Trematobolus insignis* is described and discussed, the description of the new genus and notes on its position being incorporated.)

Trematobolus Matthew, HALL and CLARKE, 1892,[b] Eleventh Ann. Rept. State Geologist New York for 1891, p. 252. (Described.)

Trematobolus Matthew, HALL and CLARKE, 1892,[b] Forty-fifth Ann. Rept. New York State Museum for 1891, p. 568. (Copy of preceding reference.)

Trematobolus MATTHEW, 1894, Trans. Roy. Soc. Canada for 1893, 1st ser., vol. 11, sec. 4, No. 8, pp. 88–90. (Except for the last paragraph, this is a copy of Matthew, 1893a, pp. 276–279.)

Trematobolus MATTHEW, 1895, Trans. New York Acad. Sci. for 1894–95, vol. 14, pp. 122–125. (A copy of the preceding reference.)

Protosiphon MATTHEW, 1897, Geol. Mag., new ser., dec. 4, vol. 4, pp. 68–69. (Described and discussed as a new genus.)

Protosiphon MATTHEW, 1898, Trans. Roy. Soc. Canada for 1898, 2d ser., vol. 4, sec. 4, No. 2, pp. 129–130. (Described and discussed.)

Trematobolus Matthew, WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 146. (Classification of genus.)

Shell rather thick, subcircular or oval in outline, biconvex; valves inarticulate. Ventral valve with the beak at or very near the posterior margin. Pedicle opening in front of the beak, at the anterior end of an elongate external groove that begins at the beak and broadens out to the foramen, which is a simple opening through the thick shell; the elongate depression and the opening through the shell are marked by strong lines of shell growth. Dorsal valve usually more convex than the ventral; beak marginal.

Shell built up of several layers or lamellæ that appear to be calcareocorneous, as the result of the replacement in part of the original shell. Cardinal area of the ventral valve short; it rises from the plane of the margins of the valves at angles varying from 25° to 85°; it varies in width and outline with the configuration of the valve. Area of dorsal valve nearly on the plane of the margins of the valves or rising at angles as high as 15°. The area of the ventral valve is divided midway by a distinct furrow that varies greatly in width and depth; in some specimens it is little more than a faintly impressed line (Pl. LXXXIII, fig. 1g) and in others it is an elongate triangular furrow (Pl. LXXXIII, fig. 1i); in some specimens the inner angle of the area next to the median furrow projects forward so as to form a toothlike knob, which, in the cast, is shown by a deep, sharp indentation on each side of the cast of the median furrow. These knobs are the teeth described by Matthew [1893a, p. 277]. They correspond to similar projections in *Obolella* (Pl. LV, figs. 1e, 1f, 3c), and *Bicia gemma* (Pl. L, figs. 1i–k). The area of the dorsal valve is narrow and divided by a central, slightly depressed triangular space; the areas of both valves are crossed by strong, sharp, transverse striæ of growth that pass uninterruptedly across the median furrow.

There are no traces of the foraminal groove on the interior of the ventral valve; it is entirely within the substance of the shell and did not form a ridge on the inside of the shell. A cast of the groove is shown in Plate LXXXIII, figure 1o.

The splanchnocœle of the ventral valve is back of the center, while in the dorsal valve it extends to the center; a median depression extends nearly to the front of the splanchnocœle of the ventral valve into which the foramen opens at about the posterior two-fifths of the

[a] The synonymy for this genus includes only those references in which the genus is discussed or described. To complete the record *Obolus* Matthew [1895a, p. 121; 1902c, p. 96] should be listed.

[b] This date (1892) is taken from the title-page and is used throughout this monograph, but the work is clearly antedated, the correct date being 1893 or 1894.

length of the depression; traces of a median septum occur in the dorsal valve. The grooves of the main vascular canals begin in each valve at the front margin of the area and arch outward and forward, and then, after passing the center of the valve, curve gently inward, terminating toward the front of the valve; only traces of the secondary radial canals have been observed. The course of the parietal scar in each valve is probably much like that of *Obolus*. The muscle scars, as far as known, are essentially the same as those of *Obolus*. In the ventral valve the transmedian (i) and anterior laterals (j) occur just outside of the line of the main vascular canals. The position of the outside (l) and middle (k) laterals and central (h) scars is within the areas (c) on each side of the anterior termination of the median depression. In the dorsal valve the centrals (h) and anterior laterals (j) are clearly defined, and the position of the transmedian (i) and outside laterals (l) is indicated. The umbonal scars are small and are situated in the ventral valve close to the sides of the anterior end of the furrow in the area; they have not been recognized in the dorsal valve. Pedicle muscle scars unknown.

Type.—*Trematobolus insignis* Matthew.

Observations.—The above description is quite unlike that given of this genus by Matthew [1893a, p. 276]. It is drawn up from specimens of *Trematobolus insignis*, lent to me, first by Dr. Matthew, and later by Prof. W. A. Parks of the University of Toronto, and a fine series of specimens collected by Mr. S. Ward Loper for the United States National Museum at the type locality. I find that the specimen illustrated and described by Matthew [1893a, p. 276, fig. 1a] as the interior of the ventral valve is a natural cast of the *exterior* of a ventral valve, preserving the cast of the area and the elongate depression formed by the advance of the pedicle opening, and that his dorsal valve (1b) is the cast of the interior of a ventral valve. The type specimen of Matthew's ventral valve [1893a, p. 276, fig. 1a] is illustrated by Plate LXXXIV, figure 5b, and the cast of it by figure 5c. The muscle scars illustrated by Matthew are slight irregularities that existed on the outer surface of the shell, along the stronger lines of growth. The type specimen of Matthew's dorsal valve [1893a, p. 276, fig. 1b] is illustrated by Plate LXXXIV, figure 5; it should be compared with the casts of the interior of the ventral valve of *Trematobolus kempanum* (Matthew) as shown by Plate LXXXIII, figures 1c and 1d.

The generic relations of *Trematobolus insignis* Matthew and *T. kempanum*, the type of the genus *Protosiphon* Matthew [1897a, p. 68], may be seen by comparing Plate LXXXIII, figure 1, with Plate LXXXIV, figure 5c, and Plate LXXXIV, figures 5 and 5a, with Plate LXXXIII, figures 1d and 1j. They appear to be generically the same. The specimens of *Trematobolus insignis* Matthew and *Protosiphon pristinus* (see *Trematobolus pristinus* (Matthew)) came from the same stratum of rock and the same locality, and, with the correct understanding of the valves of the type specimens of *T. insignis*, they may be closely compared, as is done under the description of *T. insignis*.

Trematobolus is closely related to *Schizambon*. The ventral valve in both genera has an oval pedicle opening in front of the beak at the anterior end of an external groove, tapering toward the beak; it is the progressive track of the pedicle aperture, and strong, arched lines indicate its successive positions in different stages of growth. (See Pl. LXXXIII, fig. 1o, which is a cast of the groove and opening in a thick shell.)

In *Siphonotreta* the pedicle opening is in front of the beak, but it does not advance with the growth of the shell as in *Schizambon* and *Trematobolus*. The surface of *Schizambon* is spinose while that of *Trematobolus* is nearly smooth. The shells of the latter are thick and the former relatively thin. The muscle scars, as far as known, are essentially the same in the two genera.

It is interesting to note that, with the exception of the pedicle groove and opening, *Trematobolus* and *Obolella* are closely related.

The species now referred to the genus *Trematobolus* are: *T. insignis* Matthew, *T. pristinus* (Matthew), *T. kempanum* (Matthew), and *T. excelsis* Walcott.

T. excelsis occurs in the Lower Cambrian of eastern central California. It is one of the oldest of the Cambrian brachiopods. The three species from New Brunswick are from near the base of the Middle Cambrian.

Trematobolus excelsis Walcott.

Plate LXXXII, figures 8, 8a–b.

Trematobolus excelsis Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 80–81, Pl. VIII, fig. 8. (Described and discussed as below as a new species. Fig. 8 is copied in this monograph, Pl. LXXXII, fig. 8.)

Shell transversely oval in outline, with both valves obtusely acuminate. Ventral valve strongly convex, with the minute beak at the posterior margin above a low area; the slope from the highest point of the valve, a little back of the center, is greatest toward the beak and nearly uniform to the front and sides of the valve. Pedicle opening unknown, as no exterior or cast of the exterior of the valve occurs in the material collected; two casts of the interior show the cast of the foramen at about the same position as in *T. insignis* Matthew and other species of the genus. Dorsal valve slightly more transverse than the ventral and about two-thirds as convex; a very slight median flattening occurs at the anterior margin that extends back on the valve, nearly to the beak in some specimens; otherwise the convexity is distributed as in the ventral valve.

Surface marked by a few concentric lines of growth. The shell is rather thin, except over the umbonal and posterior portions of the ventral valve, where it is moderately thick. Its substance is now calcareous, and appears like that of *T. insignis;* the original shell may have been calcareocorneous. A ventral valve 18 mm. in length has the same width; a large dorsal valve 22 mm. long has a width of 27 mm.

The area of the ventral valve is short and divided midway by a depressed subtriangular false pedicle furrow; the presence of pits on each side of the anterolateral margins of the false pedicle furrow indicates that the area at these places projected in the same manner as that of *T. insignis* Matthew and *T. kempanum* (Matthew). (Compare Pl. LXXXII, fig. 8, with Pl. LXXXIII, fig. 1c, and with Pl. LXXXIV, fig. 5.) The cast of the interior of the ventral valve shows a median ridge with the cast of the pedicle opening at about the posterior sixth of the length of the valve; only the imperfect outlines of the splanchnocœle are known; the main vascular sinuses are outlined for a short distance back of the transverse center sufficiently to indicate that their position was about the same as in *T. kempanum.* The position of the anterior lateral (j) muscle scar is clearly shown just outside of the main vascular sinuses; it is elongate oval in outline and a little in advance of the transmedian scar (i); the umbonal muscle scars are close to the median furrow, as in *T. kempanum.*

Interior of dorsal valve unknown.

Observations.—This fine species differs from all other known species of the genus in having the ventral valve more convex than the dorsal and in its greater size. It is the oldest species of the genus, occurring as it does well down in the section of the Lower Cambrian strata, in association with *Olenellus.* There are a large number of specimens of the exterior of the dorsal valve, but only two interior casts of the ventral valve. The dorsal valve of *T. pristinus* (Matthew) and *T. kempanum* (Matthew) also greatly outnumbers the ventral valve in the collections. This circumstance may be owing to the presence of the foraminal furrow and interior median furrows; these would cause the shell of the ventral valve to break more readily than that of the dorsal.

Formation and locality.—**Lower Cambrian:** (**53**) *Sandstones in the lower portion of 3d of the Waucoba Springs section;* (**312**) sandstones of 3d of the Waucoba Springs section; and (**312a**) shales of 3b of the Waucoba Springs section; all east of the Saline Valley road, east of Waucoba Springs [see Walcott, 1908f, p. 187, for position in section], Inyo County, California.

(**176** and **178a**) Shales and interbedded limestones between massive limestones containing *Archæocyathus* at the south end of Deep Spring Valley; and (**176a**) sandstone on ridge east of the head of Mazouka Canyon, Inyo Range; both in Inyo County, California.

Trematobolus insignis Matthew.

Plate LXXXIV, figures 5, 5a–c.

Trematobolus insignis Matthew, 1893, Canadian Rec. Sci., vol. 5, pp. 276–279, figs. 1a–d, p. 276. (Described and discussed as a new species. The specimens represented by figs. 1a and 1b are redrawn in this monograph, Pl. LXXXIV, figs. 5b and 5, respectively. Figs. 5c and 5a of this monograph are drawn from casts of the typical specimens, Matthew, 1893a, figs. 1a and 1b, respectively.)

Trematobolus insignis Matthew, Hall and Clarke, 1892,[a] Eleventh Ann. Rept. State Geologist New York for 1891, p. 252, fig. 263. (No text reference. Figs. 263 (1a–d) are copied from Matthew, 1893a, figs. 1a–d, respectively, p. 276.)

Trematobolus insignis Matthew, Hall and Clarke, 1892,[a] Forty-fifth Ann. Rept. New York State Museum for 1891, p. 568, fig. 263. (Copy of preceding reference.)

Trematobolus insignis Matthew, 1894, Trans. Roy. Soc. Canada for 1893, 1st ser., vol. 11, sec. 4, No. 8, pp. 88–90, Pl. XVI, figs. 4a–d. (Except for the last paragraph, this is a copy of Matthew, 1893a, pp. 276–279. Figs. 4a–d are copied from Matthew, 1893a, figs. 1a–d, respectively, p. 276.)

Trematobolus insignis Matthew, 1895, Trans. New York Acad. Sci. for 1894–95, vol. 14, pp. 122–125, Pl. IV, figs. 2a–d. (Text and figures copied from preceding reference.)

Trematobolus insignis Matthew, 1895, Bull. Nat. Hist. Soc. New Brunswick, vol. 3, No. 13, p. 95, figs. 1a–d. (No text reference. Figs. 1a–d are copied from Matthew, 1895a, Pl. IV, figs. 2a–d, respectively.)

Trematobolus insignis Matthew, 1898, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 1, No. 16, p. 35, figs. 1a–d. (No text reference. Figs. 1a–d are copied from Matthew, 1895a, Pl. IV, figs. 2a–d, respectively.)

Shell subcircular in outline, biconvex, valves inarticulate. Ventral valve gently convex, with the minute beak at the posterior margin, and above a low area. Pedicle opening a rather large, simple, oval opening at the anterior end of a furrow that gradually narrows toward the beak, where it terminates; from the lines of growth in the furrow indicating progressive stages of the advance of the foramen it is evident that the foramen began at or just in advance of the beak, and advanced with the growth of the shell in the same manner as the foramen of *Schizambon* (Pl. LXXXIV, fig. 1); the length of the foraminal furrow varies from one-third to two-fifths of the length of the valve.

The substance of the original shell appears to have been entirely removed by solution and replaced by the limestone. The closely related species *T. kempanum* (Matthew) has a calcareo-corneous shell. That the shell was strong is indicated by the depth of the vascular markings and muscle scars. The outer surface is marked by a few concentric lines of growth. The type specimen is 9 mm. in diameter.

The area of the valve is short and divided midway by a depressed, narrow, subtriangular space, bounded by narrow, slightly elevated ridges that originate just beneath the beak and diverge a little toward the margin of the area, where they unite with the margin and extend forward so as to form two short projections, one on each side of the pseudopedicle furrow on the area; the area slopes forward from the beak at an angle of about 15°; it is marked by rather strong transverse lines of growth.

There are no traces of the posterior portion of the foraminal furrow on the interior of the valve; it is entirely within the substance of the shell. The splanchnocœle extends to about the center of the valve; in front of the area a low, broad swelling begins that extends forward beyond the foraminal opening, where it divides so as to leave a short depressed space, and within, a narrow median ridge; on each side and in front of the line of the pedicle opening there are the obscure outlines of the spaces occupied by the scars of the points of attachment of the central, middle lateral, and outside lateral muscles, very much as in *Obolus* (Pl. VII); these muscle-bearing spaces are finely shown in *T. kempanum* (Matthew) and *T. pristinus* (Matthew) (Pl. LXXXIII, figs. 1d, 1j, 2c). The sinuses of the main vascular canals are broad and strong; they start near the front margin of the area near the median line and extend outward and forward subparallel to the outer margin of the valve to about the transverse median line, beyond which, owing to the broken specimen, they have not been traced. The umbonal muscle scars occur on each side of the median line just beneath the projections of the area beside the false pedicle furrow; they are small and located on a low ridge. The transmedian and anterior lateral muscle scars are elongate oval in outline, close to the outer margin of the main vascular sinus, and placed on a rounded, low ridge; the transmedian scar extends a little outside of the anterior lateral scar at its anterior end; as already stated, the central scars and the middle and outside lateral scars probably occurred in the spaces on each side of the anterior end of the low median ridge.

[a] This date (1892) is taken from the title-page and is used throughout this monograph, but the work is clearly antedated, the correct date being 1893 or 1894.

The opening of the foramen in the interior of the valve is on the low median ridge at a point three-fifths of the distance from the area to the anterior end of the median line of the splanchnocœle (visceral area).

Dorsal valve unknown.

Observations.—This species is known only by the type specimens of Matthew. These include a matrix of the ventral valve, represented by Plate LXXXIV, figure 5b, a cast of the interior of a broken ventral valve, figure 5, a fragment of the exterior of a ventral valve showing the foraminal furrow, and a fragment of the cast of the outer surface. As stated under the description of the genus, Matthew [1893a, p. 276] mistook the matrix of the ventral valve for the interior of a ventral valve, and the cast of the interior of a ventral valve for a dorsal valve. The true relations of the specimens are readily seen by comparing them with the specimens of closely allied species on Plate LXXXIII.[a]

The type material was collected from a layer of rock that is identical with, or is nearly at the same horizon as, a layer at the same locality carrying numerous specimens of *Trematobolus pristinus* (=*Protosiphon pristinus* Matthew). I would consider the latter a synonym were it not for the position and size of the vascular sinuses in the ventral valve, which are located well out toward the outer margin (compare Pl. LXXXIV, fig. 5, with Pl. LXXXIII, fig. 2c), while in *T. pristinus* they are much nearer the median line of the valve. The interior of the ventral valve of *T. insignis* is more like that of *T. kempanum* (Matthew). (Compare Pl. LXXXIV, fig. 5, with Pl. LXXXIII, figs. 1c, 1i.) Until a larger series of specimens representing *T. insignis* is collected the diagnosis of the genus must depend largely upon the material representing *T. kempanum.*

Formation and locality.—**Middle Cambrian:** (**301** [Matthew, 1895a, p. 123]) Sandstones of Division 1b2 of Matthew, on Hanford Brook, St. John County, New Brunswick, Canada.

Trematobolus kempanum (Matthew).

Plate LXXXIII, figures 1, 1a–o.

Protosiphon kempanum Matthew, 1897, Geol. Mag., new ser., dec. 4, vol. 4, pp. 70–71, figs. 1–4, p. 70. (Described and discussed as a new species.)

Protosiphon kempanum Matthew, 1898, Trans. Roy. Soc. Canada for 1898, 2d ser., vol. 4, sec. 4, No. 2, p. 131, Pl. I, figs. 1a–f. (Text is almost an exact copy of the preceding reference. Figs. 1a–d are copied from figs. 2, 1, 3, and 4, respectively, of the preceding reference.)

General form subcircular to rounded ovate, biconvex, with the dorsal valve about one-third more convex than the ventral; outline of ventral valve obtusely acuminate and dorsal valve broadly rounded posteriorly. Beak of ventral valve marginal above a well-defined area; just in front of the beak a narrow furrow starts that marks the path of advance of the pedicle opening; this furrow is usually from one-fourth to one-third the length of the shell and gradually widens and deepens up to the oval pedicle opening; strong lines of growth, with the curvature of the posterior side of the opening, mark the stages of growth and advance of the opening; these are beautifully shown by the cast of the furrow and opening illustrated by Plate LXXXIII, figure 1o. The furrow and pedicle opening are entirely in the layers of the shell and do not cause a projection on the interior of the valve; the opening is compressed in some specimens, but it is usually of good size, as is shown by a cast of it that extended from the outer to the inner surface; this is represented by figure 1c. The opening is of the same character as that of *Schizambon*, except that it is through a thick shell.

Dorsal valve proportionally a little shorter than the ventral; beak marginal.

Surface marked by a few concentric lines of growth; the inner surface appears to have been smooth. The specimens are preserved in a fine-grained sandstone, and usually in the form of casts; a few show portions of the shell, and these indicate that it was of a calcareo-corneous nature and built up of several rather strong layers or lamellæ. This is also indicated by the cast of the pedicle furrow and opening (fig. 1o).

[a] I sincerely regret being obliged to differ so greatly with my friend Doctor Matthew on the interpretation of the types of this species and of the genus *Trematobolus.*

The largest ventral valve in the collection has a length of 14 mm. and a width of 13.5 mm. A dorsal valve 13 mm. long has the same width.

The area of the ventral valve slopes backward and rises from the plane of the margins of the valve at an angle of about 45°. It is divided midway by a false pedicle area that varies in width; it is subtriangular in outline, slightly depressed, and has a narrow median furrow of varying depth that is marked by strong lines of growth; on each side of the inner end of this furrow the area is extended forward as a toothlike projection, very much as in *Bicia* (Pl. L) and *Obolella* (Pl. LV). The area is marked by transverse lines of growth subparallel to its anterior margin. The cast of the area (Pl. LXXXIII, figs. 1c, 1d, 1g, 1i, and 1k) shows the pits made by the projections of the area next to the false pedicle furrow; it was these pits in the cast of the ventral valve of *T. insignis* (Pl. LXXXIV, fig. 5) that Matthew [1893a, p. 276] mistook for the dental sockets of the dorsal valve.

The splanchnocœle of the ventral valve is large and clearly shown; the low, broad, rounded median ridge is about one-half the length of the valve; it broadens out near the pedicle opening and again toward the front; it is marked by a narrow median depression back of the pedicle opening, and, in front of the pedicle opening, by a central, elongate swell surrounded by a narrow furrow. The pedicle opening is clearly defined on nearly all casts of the valve; it is situated about two-fifths the distance from the area to the front end of the ridge on which it occurs. On each side, a short distance back of the front end, an area is outlined that extends obliquely backward to the main vascular sinus; this area may be depressed below the general surface or raised above it; it corresponds to the area in the ventral valve of *Obolus*, in which the central muscle scars and the middle and outside lateral scars occur. (Compare Pl. LXXXIII, figs. 1c, 1d, with Pl. VII, figs. 5 and 13; also with Pl. XIV, figs. 1a and 4a.) The transmedian and anterior lateral muscle scars occur on a rounded ridge just outside of the main vascular sinuses (Pl. LXXXIII, fig. 1d). The umbonal muscle scars are oval in outline and situated close to the posterior end of the central median ridge, and between the ridge and the transmedian muscle scars. The impressions made by the main vascular canals are broad, strong, and continued to the anterior third of the valve; they originate beside the median ridge close to the area, and curve outward and then inward beyond the center of the valve.

The area of the dorsal valve is narrow and divided by a central, slightly depressed, triangular space; it is marked by transverse lines of growth and appears to be on the same plane as the margins of the valves. The splanchnocœle of the dorsal valve extends forward beyond the center of the valve; it is divided by a narrow, median septum, and has an oval depression in it a little back of the anterior lateral muscle scars; the central muscle scars are large, oval in outline, and situated on the outer slope of the rounded ridge about the central depression; the anterior lateral scars are small and placed on the rounded ridge in front of the central depression and close to the median septum. A low, rounded ridge extends obliquely forward into the valve from each side of the median septum; these probably mark the position of vascular canals extending forward from the visceral area; they are shown in Plate LXXXIII, figures 1l and 1n. The transmedian and anterior lateral muscle scars are located close to the outer edge of the main vascular sinus, well back on the posterolateral part of the valve. The main vascular sinuses start back of the visceral area near the median septum and curve outward and then forward about halfway between the central muscle scars and the margin at the center of the valve, and then a little inward before terminating near the front margin.

Observations.—This fine shell was the type of Matthew's genus *Protosiphon* [1897a, p. 68]. I find it to be congeneric with *Trematobolus insignis* Matthew, and rather closely related to that species. This may be seen by comparing Plate LXXXIII, figures 1c, 1d, with Plate LXXXIV, figure 5. The pedicle furrow and aperture is much like that of *Schizambon typicalis* Walcott (Pl. LXXXIV, figs. 1, 1a) except that it is in a thick shell, while that of the latter species is in a relatively thin shell. In 1898 Mrs. Walcott and I collected a large series of specimens at the typical locality, as I wished to illustrate fully this the oldest of the Siphonotretidæ of the *Schizambon* type. The shell occurs above the *Olenellus* zone, at about the same general horizon as *T. insignis* and *T. pristinus*.

The specific name was given in honor of Prof. J. F. Kemp, of Columbia University, New York City.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**2u**) Lowest beds exposed on the south side of Long Island; and (**308g**) *shales of Division 1b3 or 1b4* [*Matthew, 1897, p. 71*] *of Matthew's section on Long Island;* both in Kennebecasis Bay [see Matthew, 1898a, pp. 124 and 127], St. John County, New Brunswick, Canada.

TREMATOBOLUS PRISTINUS (Matthew).

Plate LXXXIII, figures 2, 2a–h; Plate LXXXIV, figure 6.

Obolus pristinus MATTHEW, 1895, Trans. New York Acad. Sci. for 1894–95, vol. 14, pp. 121–122, Pl. IV, figs. 1a–d. (Described as a new species. The specimen represented by figure 1c is redrawn in this monograph, Pl. LXXXIII, fig. 2f.)

Obolus pristinus MATTHEW, 1902, Trans. Roy. Soc. Canada, 2d ser., vol. 8, sec. 4, No. 3, p. 96, Pl. I, figs. 8a–d. (Characterized. Figs. 8a–d are copied from figs. 1a–d, respectively, of the preceding reference.)

General form biconvex, subcircular to short ovate. Ventral valve rounded acuminate, sometimes a little broader than long; beak marginal above a low area. Pedicle opening at the anterior end of a furrow that gradually narrows to the beak; the foraminal furrow varies in length from about one-third to two-fifths the length of the valve; it is situated in the thickened part of the shell and does not produce a ridge on the interior of the valve. Dorsal valve proportionally a little shorter than the ventral; beak marginal; area, if present, unknown.

Surface marked by fine concentric striæ and lines of growth that show as the front margins of imbricated lamellæ of the shell; very fine radiating striæ (also a few radiating, slightly elevated lines) occur on some specimens, but whether they belong on the epidermal layer or one of the inner lamellæ is unknown; the inner surface is slightly roughened. The substance of the shell has been replaced by the calcareous matter of the matrix, but from the calcareo-corneous nature of the shell of *T. kempanum* (Matthew) it is probable that the original shell of this species was of the same nature. The shells vary in size from 5 to 13 mm. in length; the average is about 9 mm.

The area of the ventral valve is short; otherwise, nothing is known of it. The splanchnocœle extends nearly to the center of the valve; a low ridge starts near the area, and, gradually widening, passes beyond the pedicle opening into an oval depression forming the anterior portion of the visceral cavity; the ridge back of the pedicle opening is marked by a slightly raised median line; the space on each side, between the median ridge and the main vascular sinuses, has a narrow band across the front that extends from each side of the central depressed area diagonally backward to the main sinuses; these bands correspond in position to the spaces occupied by the central muscle scars and the transmedian and outside lateral scars (compare Pl. LXXXIII, fig. 2b, with Pl. VII, fig. 13, of *Obolus*); the anterior lateral muscle scar is close to the main vascular sinus, nearly opposite the pedicle opening. The main vascular sinuses start near the area on each side of the low median ridge, and, with a gentle outward curve, pass the center, and then, with a slight inward curve, reach nearly to the front margin; they do not extend laterally beyond a vertical line drawn midway between the center and lateral margins of the valve. Fine, irregular, secondary radial canals extend outward from the main canal toward the margins.

The splanchnocœle of the dorsal valve extends beyond the center; a very narrow median septum is shown, or else a broad, low, rounded ridge. The main vascular sinuses start near the median line, close to the posterior margin, and curve forward, subparallel to the lateral margins of the valve, gradually getting farther away from the margins as they pass the transverse center of the valve. The central muscle scars are elongate oval in outline and situated back of the center of the valve; the anterior laterals are small and close to the median line.

Nothing is clearly shown of the details of the area of the dorsal valve; it was probably similar to that of *T. kempanum* (Matthew). (Compare figs. 2f and 2g with figs. 1l and 1m, Pl. LXXXIII.)

Observations.—This species is closely related to *T. insignis* Matthew, reference to which is made under that species; it differs in the position of the main vascular sinuses of the ventral

valve, and in the size of the splanchnocœle. *T. kempanum* is a larger shell with different vascular and other scars in the interior of the ventral valve. Figures 2, 2a–d represent specimens collected by S. Ward Loper for the United States National Museum, and figures 2e–h represent the specimens in Matthew's collection, now at the University of Toronto.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**301** [*Matthew, 1895a, p. 122*]) *Sandstones of Division 1b2;* (**2h**) sandstones of Division 1b2; and (**2i** and **2k**) sandstones of Division 1b3; all in Matthew's [1895a, p. 108] *Protolenus* zone, on Hanford Brook, St. John County, New Brunswick, Canada.

Genus SCHIZAMBON Walcott.

[σχίζω, I divide; and ἄμβων, a raised edge.]

Schizambon WALCOTT, 1884, Mon. U. S. Geol. Survey, vol. 8, pp. 69–70. (Described and discussed as a new genus.)
Schizambonia OEHLERT, 1887, Manuel de conchyliologie, by Fischer, p. 1266. (Described in French.)
Schizambon Walcott, HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, pp. 253–254. (Described and discussed.)
Schizambon Walcott, HALL and CLARKE, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, pp. 569–570. (Copy of preceding reference.)
Schizambon Walcott, HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 113–117. (Copies the original description, Walcott, 1884b, p. 69, and discusses genus and species referred to it.)
Schizambon Walcott, WINCHELL and SCHUCHERT, 1895, Nat. Hist. Minnesota, Geology, vol. 3, pt. 1, Paleontology, p. 360. (Copies the original description, Walcott, 1884b, p. 69, and discusses genus.)
Schizambon WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 146. (Classification of genus.)

This genus is described in Monograph VIII of the United States Geological Survey [Walcott, 1884b, p. 69] and very fully in Hall and Clarke's monograph [1892c, p. 113].

The type species is illustrated in this memoir on Plate LXXXIV. The other species now referred to the genus are *S.? esthonia* Walcott, *S. manitouensis* Walcott, and *S. priscus* Matthew. As stated in the original description [Walcott, 1884b, p. 69] *Siphonotreta fissa* Kutorga appears to belong to the genus, and Hall and Clarke [1892b, pp. 115–116] include *Schizambon? canadensis* (Ami);[a] Messrs. Winchell and Schuchert [1895, pp. 361 and 362] tentatively include *S.? dodgei* and *S.? lockei*, and Mr. George H. Hudson [1904, p. 284] describes a new species, *Schizambon duplicimuratus*, from the Chazy limestone on Valcour Island, Lake Champlain, New York.

Type.—Schizambon typicalis Walcott.

SCHIZAMBON? ESTHONIA n. sp.

Plate LXXXIV, figure 4.

This species is represented by a single specimen of the ventral valve. It is nearly circular in outline and moderately convex. Apex a little in advance of the posterior margin; a slight flattening back of the apex outlines a faint false area. A wedge-shaped depression extends from the sharp apex forward a short distance to its larger end where the large oval foramen occurs; this depression is similar to that in *Schizambon typicalis* Walcott and *S. fissa* (Kutorga); it is marked by fine lines of growth back of the foramen. Surface marked by fine concentric lines of growth and three narrow, low, concentric ridges or varices of growth; the entire surface is finely granulated, the granules being formed apparently by the crossing of fine, curving, oblique furrows that start on the posterolateral margin and curve forward obliquely across the shell, crossing so as to form rhomboidal spaces in which the granules occur. This type of surface is unlike the spinose surface of *S. typicalis*. It suggests the surface of *Micromitra* and some forms of *Obolus* (*Westonia*). From some points of view the crossing of the depressed lines gives a punctate appearance to the surface.

It may be that this shell belongs to some other genus, but with the present information it is referred to *Schizambon*.

The specific name is derived from Esthonia.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**336h**) Ungulite grit, at Baltischport, Esthonia, Russia.

[a] *Siphonotreta scotica canadensis* Ami, 1887, Ottawa Naturalist, vol. 1, No. 9, p. 124.

Schizambon manitouensis n. sp.

Plate LXXXIV, figures 3, 3a–e.

General form and convexity much like those of *Schizambon typicalis* Walcott, also surface characters if the influence of the different matrix is allowed for. The differences between the two species are in the larger foramen in *S. manitouensis;* in a shorter depression before the beak; in the interior markings of the dorsal valve and the strong area of the dorsal valve (Pl. LXXXIV, fig. 3c). There may be a similar area in *S. typicalis*, but owing to the condition of preservation it has not been observed.

The finely spinose surface is rarely seen, as it adheres to the matrix. The usual appearance of the shell is like that shown by figure 3. The average shell has a length of 4.5 mm., width about the same. Substance corneous.

The specific name is derived from Manitou, Colorado.

Formation and locality.—**Lower Ordovician:** (**186** and **186a**)[a] *Near line of contact between the red and gray Ordovician limestone, in siliceous red limestone about 30 feet (9.1 m.) above the pre-Cambrian rocks, Williams Canyon, Manitou;* and (**360**) red siliceous limestone near Colorado Springs; both in El Paso County, Colorado.

Schizambon priscus Matthew.

Plate LXXXIV, figures 2, 2a–e.

Schizambon priscus Matthew, 1901, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 4, No. 19, pp. 277–278, Pl. V, figs. 4a–d. (Described and discussed as a new species. None of the specimens figured are reproduced in this monograph.)

Schizambon priscus Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 187–189, Pl. XI, figs. 6a–d. (Description and figures copied from preceding reference.)

Shell small and subcircular to transversely ovate, moderately convex. Ventral valve slightly acuminate, with the apex above a short false area, and lower than the umbo. Foramen small, oval, and opening externally into an elongate groove tapering toward the beak; back of the foraminal opening a tapering ridge extends to the beak, leaving a narrower groove on each side. In the interior of the shell the edges of the tapering groove are slightly elevated and the foraminal opening appears to be of about the same size as the external opening. On some specimens of the ventral valve, on each side of the foramen on the outer surface, a narrow depression extends forward and slightly outward nearly to the front margin; this character corresponds to the low ridges in the ventral valve of *Schizambon typicalis* Walcott (Pl. LXXXIV, fig. 1a).

The dorsal valve is less convex than the ventral, and its beak is marginal. The interior of the valve shows a median ridge of varying strength, and the same is true of the ridges indicating the narrow main vascular canals. In figure 2c the anterior portion of the median ridge is shown, also the oval, widely separated central muscle scars (h) and the small anterior lateral scars (j); in figure 2d the main vascular canals and the central portion of the median sinuses are shown. In figure 2e there is only a trace of vascular markings.

Surface as preserved, marked by very fine radiating and concentric ridges that form on some shells a cancellated pattern; the fact that many shells adhere by the outer surface to the matrix leads me to suspect that the outer surface is roughened and probably spinose as in other species of the genus. The average size of the shells is about 4 mm. in length and width. Shell substance corneous.

Formation and locality.—**Upper Cambrian:** (**10f** and **10g**) Shales on the east branch of Barachois River, 0.75 mile (1.2 km.) north of the crossroad from Boisdale to Upper Leitches Creek; (**10h**) at same locality as Locality 10f, but in shales of a slightly different horizon; (**10e**) shales on the east branch of Barachois River, 0.5 mile (0.8 km.) north of the crossroad from Boisdale to Upper Leitches Creek; (**10l**) shale on east bank of Barachois River, 6 miles (9.6 km.) from Little Bras d'Or Lake; (**13h**) shale on the east bank of Barachois River, 1.5 miles (2.4 km.) north of Boisdale; (**10k**) shale on west bank of Barachois River, about 0.25 mile (0.4 km.) north of the Boisdale road; (**10d**) shale on the west side of Barachois River, 0.125 mile (0.2 km.) north of the Boisdale road, opposite McMullin's place; (**10i**) shale in high bank on the west side of Barachois River, just north of the Boisdale road; (**307** [*Matthew, 1903, p. 188*]) *shales of Division C3c of Matthew on McLeod Brook (=Barachois River);* (**3q**) shale in Barachois Glen, 4 miles

[a] **186a** is the type locality.

(6.4 km.) south of Little Bras d'Or Lake; (3h) shale and shaly limestone on McNeil Brook, 1.5 miles (2.4 km.) east of Marion Bridge; and (372e [Matthew, 1903, p. 50]) shales on McMullins Brook, near McLeod Brook (=Barachois River); all in eastern Cape Breton, Nova Scotia, Canada.

(308 [Matthew, 1901a, p. 278]) Shales of Division C3c of Matthew at Navy Island, St. John Harbor, St. John County, New Brunswick, Canada.

Specimens somewhat doubtfully referred to this species occur at the following locality:

Upper Cambrian: (10c) Shales in a horizon 50 feet below that of Locality 10k, on the west side of Barachois River, eastern Cape Breton, Nova Scotia, Canada.

Schizambon typicalis Walcott.

Plate LXXXIV, figures 1, 1a–d.

Schizambon typicalis Walcott, 1884, Mon. U. S. Geol. Survey, vol. 8, pp. 70–71, Pl. I, figs. 3, 3a–d. (Described and discussed as a new species. Figs. 3, 3a–d are copied in this monograph, Pl. LXXXIV, figs. 1a, 1, 1c, 1b, and 1d, respectively.)

Schizambon typicalis Walcott, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 253, Pl. IV, figs. 18–20. (Mentioned under genus *Schizambon*. Fig. 18 is copied from Walcott, 1884b, Pl. I, fig. 3a.)

Schizambon typicalis Walcott, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 114, 116, and 117; fig. 65, p. 114; and Pl. IV, figs. 27–30. (Mentioned in discussion of genus *Schizambon*. Fig. 65 is copied from Walcott, 1884b, Pl. I, fig. 3a. Figs. 27 and 29 are copied from figs. 19 and 20, respectively, of the preceding reference.)

This species is fully described in Monograph VIII of the United States Geological Survey [Walcott, 1884b, pp. 70–71]. There is little to add to the description. For comparison with the other species the original figures are reproduced.

Among the fossils occurring in limestone bowlders from Locality 30w there is a single specimen of a ventral valve of a shell that appears to be identical with *Schizambon typicalis*. The points of identity are: (a) general form; (b) shape of foraminal opening; (c) fine, elevated, concentric striæ. The only difference is the greater convexity, which is owing, I think, to the character of the matrix, the Nevada specimen being in a shaly limestone and somewhat compressed.

Formation and locality.—**Lower Ordovician:** (201a) *Pogonip limestone, east slope of the ridge east of Hamburg Ridge, Eureka district* [*Hague, 1892, Atlas*], *Eureka County, Nevada.*

Upper Cambrian: (30w) Drift bowlder of limestone supposed to have come from 1a of the Notch Peak limestone on Notch Peak [Walcott, 1908f, p. 175], found about 2 miles (3.2 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County; (33d)[a] thin-bedded blue limestone at the base of the first high point southwest of the J. J. Thomas ranch, on the east side of the Fish Spring Range, Juab County; and (54c) about 1,100 feet (335.3 m.) above the Middle Cambrian and 120 feet (36.6 m.) below the top of the Upper Cambrian in the central portion of the limestone forming 1 of the St. Charles formation [Walcott, 1908f, p. 192], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County; all in Utah.

Genus SIPHONOTRETA de Verneuil.[b]

[σίφων, a siphon or tube; τρητός, perforated.]

Crania Eichwald (in part) [not Retzius], 1829, Zoologia specialis, vol. 1, p. 273. (Described in Latin. The genus includes species other than those belonging with *Siphonotreta*.)

Terebratula Eichwald (in part) [not Lhwyd], 1840, Jour. Natur- und Heilkunde Medizinischen Akad. St. Petersburg, pts. 1 and 2, p. 138 (p. 24 in second part of one edition). (Merely places "*Crania unguiculata* and *C. verrucosa*" in this genus.)

Terebratula Eichwald, 1842, Die Urwelt Russlands, Hft. 2, p. 145. (Merely mentions "*Terebratula unguiculata.*")

Siphonotreta de Verneuil, 1845, Géologie de la Russie d'Europe, by Murchison, de Verneuil, and de Keyserling, vol. 2, pt. 3, p. 286. (Described in French as a new genus.)

Siphonotreta de Verneuil, Kutorga (in part), 1848, Verhandl. Russ.-kais. min. Gesell. St. Petersburg for 1847, No. 12, pp. 261–263. (Described and discussed in German. Notes on the genus occur at various places on pp. 250–260.)

Siphonotreta de Verneuil, Morris, 1849, Annals and Mag. Nat. Hist., 2d ser., vol. 4, pp. 315–320. (Notes on the genus and its generic relations.)

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[a] This species is somewhat doubtfully identified from this locality.

[b] The synonymy for this genus is not complete; it includes only those references dealing with the species taken up in this monograph.

Siphonotreta de Verneuil, Morris, 1850, Rept. British Assoc. Adv. Sci. for 1849, Notices and Abstracts, pp. 57–58. (Notes on the genus.)

Siphonotreta de Verneuil, Davidson, 1853, British Fossil Brachiopoda, vol. 1, Introduction, No. 3, pp. 131–133. (Described and discussed.)

Siphonotreta de Verneuil, Eichwald, 1860, Lethæa rossica, ancienne période, vol. 1, sec. 2, p. 915. (Described in French.)

Siphonotreta de Verneuil, Seebach, 1865, Zeitschr. Deutsch. geol. Gesell. for 1865, Bd. 17, Heft. 2, p. 341. (Discussed in German.)

Siphonotreta de Verneuil, Davidson, 1866, British Fossil Brachiopoda, vol. 3, pt. 7, No. 1, p. 75. (Mentioned.)

Siphonotreta de Verneuil, Quenstedt (in part), 1871, Petrefactenkunde Deutschlands, Abth. 1, Bd. 2, Brachiopoden, pp. 673–674. (Described and discussed in German.)

Siphonotreta de Verneuil, Davidson, 1877, Geol. Mag., new ser., dec. 2, vol. 4, pp. 13–16. (Notes on the genus and its generic relations.)

Siphonotreta de Verneuil, Zittel, 1880, Handbuch der Palæontologie, Bd. 1, Abth. 1, pp. 665–666. (Described in German.)

Siphonotreta de Verneuil, Davidson, 1883, British Fossil Brachiopoda, vol. 5, pt. 2, pp. 217–219. (Discussed.)

Siphonotreta de Verneuil, Oehlert, 1887, Manuel de conchyliologie, by Fischer, p. 1265. (Described in French, with figures of *S. unguiculata* and *S. verrucosa*.)

Siphonotreta de Verneuil, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, pp. 252–253. (Described.)

Siphonotreta de Verneuil, Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, pp. 568–569. (Text copied from preceding reference.)

Siphonotreta de Verneuil, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 110–113. (Described and discussed.)

Siphonotreta de Verneuil, Winchell and Schuchert, 1895, Nat. Hist. Minnesota, Geology, vol. 3, pt. 1, Paleontology, p. 358. (Copies the description given by Hall and Clarke, 1892c, pp. 110–111.)

Siphonotreta de Verneuil, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 146. (Classification of genus.)

For the diagnosis of the genus, see Hall and Clarke [1892c, pp. 110–113].

The following notes are the result of the study of casts of a natural mold of the interior of the two valves united that I worked out from a specimen of *S. unguiculata* (Pl. LXXXI, figs. 6, 6a–b) received from Dr. Fr. Schmidt, in which the transverse diameter is 18 mm.

The cast of the interior of the ventral valve shows that the visceral area was elevated on a thickening of the shell, and that the muscle scars were attached in depressions in front of and beside the elevated visceral area; the main vascular canal was also on a ridge where it passed from the anterolateral edge of the visceral area. The points of attachment of the central, outside lateral, and middle lateral scars are not clearly defined as distinct scars in the specimens at hand, but the space occupied by them is very distinctly marked. It is very much like that of *Obolus apollinis* Eichwald (Pl. VII). The points of attachment of the transmedian and anterior lateral muscles are close to the elevated visceral area, just outside of the ridge beneath the main vascular sinuses. The opening of the pedicle tube is not well preserved; this feature is illustrated by Davidson [1877, Pl. II, figs. 8 and 9].

The interior of the dorsal valve shows a thickening of the shell in front of the anterolateral muscle scars so as to form a transverse ridge that unites with the median ridge and a ridge on each side that appears to have been beneath the main vascular canals; within the subtriangular space thus formed the rather large anterolateral muscle scars occur as pits, and a little back of them, and of about the same size, the elongate oval central muscle scars; outside of the lateral ridge occur three large oval scars that correspond in position to the transmedian, outside lateral, and middle lateral scars of the dorsal valve of *Obolus*.

The specimens studied by Davidson illustrate the interior of the ventral valve somewhat better than those before me, but the interior of the dorsal valve does not appear to have been so good.

Type.—Crania unguiculata Eichwald.

Siphonotreta? dubia n. sp.

Plate LXXXI, figures 7, 7a–b.

Shell small, subcircular in outline. Ventral valve subconical, with the apex a short distance in front of the posterior margin and directed backward; it is truncated by a small, round

opening that penetrates through the shell, but whether the opening is continued as a tube is unknown; a false area is slightly indicated on the slope between the pedicle aperture and the gently upward-arching posterior margin. Dorsal valve depressed in some examples so as to be slightly concave between the minute beak at the posterior margin and the front; in other examples it is flat and in some slightly convex.

Surface of both valves marked by concentric lines of growth and low ridges from which spine bases extend across to the front edge of the next ridge, very much as in *Siphonotreta unguiculata* (Eichwald) (Pl. LXXX); the spine bases are short and scattered on the posterior parts, numerous and elongated toward the front and lateral margins in the adult shells.

The average diameter of the valves is from 3 to 4 mm. Substance of shell probably calcareocorneous; it is calcareous in the specimens, but this appears to have been the result of replacement of the original shell by impure calcite, which has also replaced the substance of associated trilobite tests.

The generic reference is doubtful, as nothing is known of the interior of either valve. The circular pedicle opening distinguishes the species from *Schizambon typicalis* Walcott, which has a similar spinose surface (Pl. LXXXIV, fig. 1d), and relates it to *Siphonotreta*. I think that with full knowledge of this species it will be found to belong to an undefined genus, as it is not probable that *Siphonotreta* was developed so early in Cambrian time.

This form owes its specific name to the doubtfulness of the generic reference.

Formation and locality.—**Lower Cambrian:** (1v) Shales of No. 3 of the Silver Peak group, Barrel Spring section [Walcott, 1908f, p. 189], 3 miles (4.8 km.) north of Valcalda Spring and 4 miles (6.4 km.) west-northwest of the Drinkwater mine, Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County, Nevada.

Siphonotreta unguiculata (Eichwald).

Plate LXXXI, figures 6, 6a–e.

Crania unguiculata Eichwald, 1829, Zoologia specialis, vol. 1, p. 274, Pl. IV, fig. 3. (Described in Latin as a new species.)

Crania sulcata Eichwald, 1829, idem, p. 274, Pl. IV, fig. 4. (Described in Latin as a new species.)

Terebratula unguiculata Eichwald, 1840, Jour. Natur- und Heilkunde Medizinischen Akad. St. Petersburg, pts. 1 and 2, pp. 138–140 (pp. 24–26 in second part of one edition). (Described in German.)

Terebratula unguiculata Eichwald, 1842, Die Urwelt Russlands, Hft. 2, p. 145, Pl. IV, figs. 2a–b. (Mentioned in German.)

Siphonotreta unguiculata (Eichwald), de Verneuil, 1845, Géologie de la Russie d'Europe, by Murchison, de Verneuil, and de Keyserling, vol. 2, pt. 3, pp. 286–287, Pl. I, fig. 13. (Described in French.)

Siphonotreta unguiculata (Eichwald), Kutorga, 1848, Verhandl. Russ.-kais. min. Gesell. St. Petersburg for 1847, No. 12, pp. 264 and 284, Pl. VI, figs. 1a–d, 2a–c, 3a–c. (Described in German on p. 264.)

Siphonotreta unguiculata var. α Kutorga, 1848, idem, p. 284, Pl. VI, figs. 4a–e. (The description of this variety may be incorporated with that of the species on p. 264; it is only mentioned, however, in the description of Pl. VI, which is on p. 284.)

Siphonotreta unguiculata var. β Kutorga, 1848, idem, pp. 264–265, Pl. VI, figs. 5a–d. (Characterized in German.)

Siphonotreta unguiculata var. γ *elongata* Kutorga, 1848, idem, p. 265, Pl. VI, figs. 6a–b. (Characterized in German as a new variety.)

Siphonotreta unguiculata (Eichwald), Davidson, 1853, British Fossil Brachiopoda, vol. 1, Introduction, No. 3, Pl. IX, figs. 261–265, 269 and 270. (Mentioned on p. 133. Fig. 269 is copied from Kutorga, 1848, Pl. VI, fig. 1a.)

Siphonotreta unguiculata Eichwald, 1860, Lethæa rossica, ancienne période, vol. 1, sec. 2, pp. 915–916. (Described and discussed in French.)

Siphonotreta unguiculata (Eichwald), Schmidt, 1861, Archiv für Naturkunde Liv-, Ehst-, und Kurlands, 1st ser., Bd. 2, p. 218. (Localities mentioned.)

Siphonotreta unguiculata (Eichwald), Quenstedt, 1871, Petrefactenkunde Deutschlands, Abth. 1, Bd. 2, Brachiopoden, p. 674, Pl. LXI, figs. 23–27. (Discussed.)

Siphonotreta unguiculata (Eichwald), Davidson, 1877, Geol. Mag. new ser., dec. 2, vol. 4, footnote and figs. A and B, p. 14; p. 15, Pl. II, figs. 7–11. (Described and discussed. Fig. 9 is copied in this monograph, Pl. LXXXI, fig. 6c.)

Siphonotreta unguiculata (Eichwald), Zittel, 1880, Handbuch der Palæontologie, Bd. 1, Abth. 1, p. 666, figs. 489a–d. (No text reference. Figs. 489a–d are copied from Davidson, 1853, Pl. IX, figs. 265, 264, 262, and 261, respectively.)

Siphonotreta unguiculata (Eichwald), Walcott, 1884, Mon. U. S. Geol. Survey, vol. 8, p. 16, Pl. I, fig. 8. (Discussed. Fig. 8 is copied from Davidson, 1877, Pl. II, fig. 9.)

Siphonotreta unguiculata (Eichwald), QUENSTEDT, 1885, Handbuch der Petrefactenkunde, Auflage 3, p. 755, Pl. LVIII, fig. 53. (Discussed in German.)

Siphonotreta unguiculata (Eichwald), GAGEL, 1890, Beitr. zur Natnrkunde Preussens, von Physikal.-oekonom. Gesell. Königsberg, 6, p. 23, Pl. I, fig. 3. (Characterized in German.)

Siphonotreta unguiculata (Eichwald), HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 253, Pl. IV, figs. 22–26. (Mentioned. Figs. 22 and 23 are copied from Davidson, 1877, Pl. II, figs. 9 and 11, respectively. Figs. 24–26 are copied from Kutorga, 1848, Pl. VI, figs. 2c, 3b, and 3a, respectively.)

Siphonotreta unguiculata (Eichwald), HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 111, Pl. IV, figs. 22–26. (Mentioned. Figs. 22–26 are copied from those in the preceding reference, which see.)

The characters of this species are included in the generic description given by Messrs. Hall and Clarke [1892c, p. 110]. It differs from *S. verrucosa* (Eichwald) in its broader outline and more finely granulated and spinose surface. Figs. 6, 6a, and 6b are of a specimen received from Dr. Fr. Schmidt; fig. 6c is copied from Davidson [1877, Pl. II, fig. 9].

FORMATION AND LOCALITY.[a]—**Ordovician**: (**336g**) Limestone in the vicinity of Zarskoe Selo; (**336w**) near Pawlowsk; and (**336x**) in the Archangel quarry on the Volkhof (Wolchow); all near St. Petersburg, Russia.

(**336v**) *Echinosphærites* limestone at Reval; (**337d**) "Brandschiefer" at Salla, near Erras, 85 miles (137 km.) east of Reval; and (**337e**) "Jewesche Schicht" at Altenhof, near Pöddrus, 55 miles (88.6 km.) east of Reval; all in the Government of Esthonia, Russia.

Drift bowlders of *Echinosphærites* limestone at the following localities: (**386i**) Near Wehlau, 30 miles (48.3 km.) east of Konigsberg, East Prussia; (**386j**) at Belschwitz, East Prussia; (**386k**) near Wormditt, East Prussia; and (**3861**) near Marienwerder, West Prussia; all in Germany.

Passage beds between the Upper Cambrian and the Ordovician: (**336e**) *Orthoceratite* limestone at Pulkowa; (**337m**) *Orthoceratite* limestone at Popowka; (**337k**) *Orthoceratite* limestone on the banks of Wolchow (Volkhof) River, near Lake Ladoga; and (**336y**) glauconitic limestone at Popowka; all near St. Petersburg, Russia.

Orthoceratite limestone ("Vaginatenkalk") at the following localities: (**336z**) At Narwa; (**337**) at Erras, 85 miles (137 km.) east of Reval; (**337a**) at Kusal, 25 miles (40 km.) east of Reval; (**337b**) [b] *at Reval;* (**337c**) on Odensholm Island, 55 miles (88.6 km.) west of Reval; and (**3371**) at Baltischport, west of Reval; all in the Government of Esthonia, Russia.

SIPHONOTRETA VERRUCOSA (Eichwald).

Plate LXXXI, figures 5, 5a–b.

Terebratula verrucosa EICHWALD, 1840, Jour. Natur- und Heilkunde Medizinischen Akad. St. Petersburg, pts. 1 and 2, pp. 140–141 (pp. 26–27 in second part of one edition). (Described in German.)

Siphonotreta verrucosa (Eichwald), DE VERNEUIL, 1845, Géologie de la Russie d'Europe, by Murchison, de Verneuil, and de Keyserling, vol. 2, pt. 3, p. 287, Pl. I, figs. 14a–d. (Described in French.)

Siphonotreta verrucosa (Eichwald), KUTORGA, 1848, Verhandl. Russ.-kais. min. Gesell. St. Petersburg for 1847, No. 12, pp. 266–267, Pl. VII, fig. 1. (Described in German.)

Siphonotreta verrucosa (Eichwald), MORRIS, 1849, Annals and Mag. Nat. Hist., 2d ser., vol. 4, Pl. VII, figs. 2a–d. (No text reference. Description of plate on p. 321.)

Siphonotreta verrucosa (Eichwald), DAVIDSON, 1853, British Fossil Brachiopoda, vol. 1, Introduction, No. 3, Pl. IX, figs. 267 and 268. (Mentioned on p. 133.)

Siphonotreta verrucosa EICHWALD, 1860, Lethæa rossica, ancienne période, vol. 1, sec. 2, pp. 916–917. (Described and discussed in French.)

Siphonotreta verrucosa (Eichwald), SCHMIDT, 1861, Archiv. für Naturkunde Liv-, Ehst-, und Kurlands, 1st ser., Bd. 2, p. 218. (Localities mentioned.)

Siphonotreta verrucosa (Eichwald), QUENSTEDT, 1871, Petrefactenkunde Deutschlands, Abth. 1, Bd. 2, p. 674, Pl. LXI, figs. 28–30. (Discussed.)

Siphonotreta verrucosa (Eichwald), QUENSTENT, 1885, Handbuch der Petrefactenkunde, Auflage 3, p. 755, Pl. LVIII, figs. 52 and 54. (Discussed in German.)

Siphonotreta verrucosa (Eichwald), GAGEL, 1890, Beitr. zur Naturkunde Preussens, von Physikal-oekonom. Gesell. Königsberg, 6, p. 22, Pl. I, figs. 2a–b. (Characterized in German.)

This beautiful and instructive species is described by de Verneuil [1845, p. 287]. Figures 5, 5a, and 5b are drawn from a specimen received from Dr. Fr. Schmidt. The outer opening of the pedicle tube is a little longer than wide, and slightly pointed toward the minute beak, which is at its posterior margin. There is no trace of a groove or pseudodeltidium on the false area of this species or *Siphonotreta unguiculata.*

[a] Localities **336y** and **337m** are represented in the United States National Museum collections; the other localities are taken from the references in the synonymy. The authority for each reference cited will be found in the list of localities, pp. 161–291.

[b] May be the type locality. Eichwald [1829, p. 274] gives it as "limestone at Reval."

FORMATION AND LOCALITY.[a]—**Ordovician**: (**336w**) Near Pawlowsk, near St. Petersburg, Russia.

Drift bowlders of *Echinosphærites* limestone at the following localities: (**386i**) Near Wehlau, 30 miles (48.3 km.) east of Konigsberg, East Prussia; (**386k**) near Wormditt, East Prussia; and (**386 l**) near Marienwerder, West Prussia; all in Germany.

Passage beds between the Upper Cambrian and the Ordovician: (**336e**) *Orthoceratite* limestone at Pulkowa; (**337m**) *Orthoceratite* limestone at Popowka; and (**336y**) glauconitic limestone at Popowka; all near St. Petersburg, Russia.

(**337f**) "Vaginatenkalk"[b] at Türsel, 15 miles (24.2 km.) west of Narwa; and (**337g**) "Vaginatenkalk"[b] at Chudleigh, 25 miles (40 km.) west of Narwa; both in the Government of Esthonia, Russia.

Genus KEYSERLINGIA Pander.[c]

Orbicula DE VERNEUIL (in part) [not LAMARCK], 1845, Géologie de la Russie d'Europe, by Murchison, de Verneuil, and de Keyserling, vol. 2, pt. 3, p. 288. (Described and discussed in French. Of the species included in the genus only "*Orbicula buchii*" is treated in this monograph.)

Not *Orbicella* DANA, 1846; see Scudder's Nomenclator Zoologicus, p. 236. (Proposed for a genus of the Polypi.)

Orbicella D'ORBIGNY (in part) [not DANA], 1850, Prodrome de Paléontologie, vol. 1, p. 20. (Characterized in French. "*Orbicella buchi*" is the only one of the many species placed under the genus which is treated in this monograph.)

Keyserlingia PANDER, 1861, Bull. Acad. imp. sci. St.-Pétersbourg, tome 3, columns 46–48. (Described and discussed in German.)

Keyserlingia Pander, DALL, 1877, Bull. U. S. Nat. Mus. No. 8, p. 39. (Merely listed, but gives "*Orbicula reversa*" as the type.)

Orbicella d'Orbigny, DALL (in part), 1877, idem, p. 50. (Cites *Orbicella buchi* as the type and gives synonymy of genus.)

Keyserlingia Pander, OEHLERT, 1887, Manuel de conchyliologie, by Fischer, p. 1263. (Described in French, with figures of *Keyserlingia buchi*.)

Not *Keyserlingia* KARPINSKY, 1887, Bull. Acad. imp. sci. St.-Pétersbourg, tome 31, p. 476, footnote. (The use of the name *Keyserlingia* in this reference is clearly a typographical error, "*Helmersenia*" being the proper term.)

Orbicella d'Orbigny, HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 254. (Pander's original description, 1861, p. 46, translated.)

Orbicella d'Orbigny, HALL and CLARKE, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, p. 570. (Copy of preceding reference.)

Keyserlingia Pander, HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 117–119. (Copies the translation of Pander's original description given by Hall and Clarke, 1892a, p. 254, and discusses the genus and the priority of the generic names proposed for it.)

Keyserlingia Pander, WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 146. (Classification of genus.)

The description of the type species, *Keyserlingia buchi*, gives all that is known of this genus. My description and remarks are based on the study of a considerable number of specimens collected for me by Mr. Schmalensee at Jaggowal, Esthonia, and a few received from Dr. Fr. Schmidt, collected at Kunitz, Government of Pskow.

From the means of comparison with other related generic forms it appears that *Keyserlingia* has an interior pedicle tube somewhat like that of *Siphonotreta unguiculata* (Eichwald), but that the pedicle cleft is back of the apex as in *Schizotreta elliptica* Kutorga. A young shell has a very clear opening in the pedicle cleft, but in nearly all adult shells the opening is closed. In the interior of the ventral valve of many shells the pedicle tube extends forward into the valve (Pl. LXXXI, fig. 4a), but in adult shells it is often closed by a vesicular growth of shell (fig. 4b).

Keyserlingia, as exemplified by *K. buchi*, is a form having an external pedicle cleft back of the apex much like that of *Schizotreta*, and an interior pedicle tube extending forward a varying distance but not usually beyond the center.

Type.—*Orbicula buchi* de Verneuil.

The generic name was given in honor of A. de Keyserling.

KEYSERLINGIA BUCHI (de Verneuil).

Plate LXXXI, figures 4, 4a–e.

Orbicula buchii DE VERNEUIL, 1845, Géologie de la Russie d'Europe, by Murchison, de Verneuil, and de Keyserling, vol. 2, pt. 3, pp. 288–289, Pl. XIX, figs. 1a–c. (Described and discussed in French as a new species.)

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[a] Localities **336y** and **337m** are represented in the United States National Museum collections; the other localities are taken from the references in the synonymy. The authority for each of the localities cited will be found in the list of localities, pp. 161–291. I have been unable to determine which is the type locality.

[b] The *Vaginoceras* limestone is the equivalent of the *Orthoceratite* limestone.

[c] The synonomy for this genus is not complete; it includes only those references dealing with the species taken up in this monograph.

Orbicella buchi D'ORBIGNY (in part), 1850, Prodrome de Paléontologie, vol. 1, p. 20. (Changes generic reference, but includes "*Orbicula reversa*" also as a synonym of "*Orbicella buchi*.")

Discina buchii (de Verneuil), EICHWALD (in part), 1860, Lethæa rossica, ancienne période, vol. 1, sec. 2, p. 914. (Described and discussed in French. Eichwald includes Jeremejew's *Siphonotreta ladogensis* as a synonym.)

Keyserlingia buchi (de Verneuil), PANDER, 1861, Bull. Acad. imp. sci. St.-Pétersbourg, tome 3, columns 46–48, Pl. II, figs. 1a–h. (Described and discussed in German.)

Orbicella buchi (de Verneuil), HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 254, Pl. IV, figs. 8–10. (Mentioned as the type species. Figs. 8, 9, and 10 are copied from Pander, 1861, Pl. II, figs. 1a, 1h, and 1c, respectively.)

Keyserlingia buchi (de Verneuil), HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 118, Pl. IV, figs. 1–3. (Note fixing "*K. buchi*" as the type species. Figs. 1–3 are copied from Hall and Clarke, 1892a, Pl. IV, figs. 9, 10, and 8, respectively.)

Shell inequivalve, circular, or slightly oval longitudinally or transversely. Ventral valve depressed conical with the apex from just in front of the posterior margin to one-fifth of the length of the valve toward the front margin; a roughly outlined false area is formed by the incurving of the posterior slope from each side beneath the apex, to a narrow cleft that extends downward from the apex a varying distance toward the posterior margin; the narrow cleft is usually closed at the bottom, but in some examples it has a small elongate opening midway and in others a minute rounded opening toward the lower or posterior part. The exterior of the dorsal valve is slightly convex with the apex marginal. Surface marked by fine, concentric striæ and a few stronger lines of growth that pass beneath the apex across the false area except where interrupted by the pedicle cleft; when the latter is closed the striæ do not cross the shell substance at the bottom of the cleft. In addition there are faint traces of fine radiating striæ and on some ventral valves a few obscure, low, radiating ridges.

The area of the ventral valve rises from the plane of the margins of the valve at an angle of about 45°; it is slightly arched inward at the center, and is marked by strong striæ of growth parallel to the outer margin. Within the valve a median ridge of varying strength and length extends forward from the front margin of the area. In fifteen examples it is less than one-half the distance to the front margin, and in only one it extends forward beyond the center. On all unbroken specimens a strong projection extends upward from the median ridge just in advance of the area; it is narrow at the base, widening sideways and backward; it has a large variously shaped anterior opening that narrows toward the base of the projection; the size of the projection and opening depends upon the amount of shelly matter that has been deposited on and in it. The opening is the inner end of the pedicle tube; in some examples it is entirely filled with shelly deposit (Pl. LXXXI, fig. 4b), and in others it is still open; in several examples with an open interior aperture the pedicle cleft is closed at the exterior end. The median ridge, in front of the pedicle tube, has a vesicular interior that gives it a hollow appearance when the top is broken away. In several examples the pedicle muscle scar is clearly preserved, on the projection from the median ridge, just in front of the opening of the pedicle tube. On each side of the median ridge close to the area the cardinal muscle scars are either in a depressed pit or on a more or less elevated projecting growth of shell rising from the bottom of the valve; sometimes the projections extend beyond the plane of the margins of the valve (Pl. LXXXI, fig. 4c), and often the central projection about the pedicle tube extends above the plane of the margin. On some shells the area indicated as the cardinal scar shows the points of attachment of three muscles, probably the umbonal, transmedian, and anterior laterals; the only indication of the points of attachment of the muscles corresponding to the central, outside, and middle laterals of *Obolus* is on the sides and beside the elevated pedicle tube.

The area of the dorsal valve has a broad, triangular, slightly concave space at the center that is bounded by narrow flexure lines; on each outer side of the flexure line the area narrows and slopes upward at an angle of about 30° to 45°; it is marked by distinct lines of growth that cross the central depressed space subparallel to the margin of the area. Within the valve a strong median septum extends from the area to the front part of the valve; this septum when broken shows an interior vesicular structure that gives the appearance of its having been hollow. Well toward the front an oval muscle scar (central) occurs on each side of the septum; the cardinal muscle scars are oval in outline close to the area and surrounded by a more or less thickened

shell growth in old shells. Between the large cardinal scars and the outer margin there is a narrow, elongate, depressed area in which the outside and middle lateral muscles may have been attached.

Shell substance corneous. The shell is built up of numerous thin layers or lamellæ, and the thick growth of the old shells is by irregular accretions. The average size of the shells is 5 to 7 mm. in diameter.

Observations.—This interesting form was evidently in its younger stages a siphonate shell that had its pedicle tube closed by shell growth in the adult stage. I have broken several ventral valves on the line of the pedicle cleft and found that the shell within the cleft has a vesicular structure and that the opening could not be traced through the shell. The filling up of the pedicle tube and the deposition of shelly matter about the interior opening of the tube appear to have been a phase of adult growth and old age. The filling of the tube must have cut off the pedicle and left the shell to drift about very much as in the case of *Leptæna rhomboidalis* and *Rhynchotrema capax* [Hall and Clarke, 1894, p. 184].

This species differs from *Orbicula reversa* de Verneuil [1845, p. 289] in having the apex of the ventral valve much nearer the posterior margin.

Formation and locality.—**Upper Cambrian:** (**395**) *Obolus* sandstone at Joa, near Jegelecht, 12 miles (19.3 km.) east of Reval, Government of Esthonia; (**395b**) *Obolus* sandstone at Ilgast, Government of Esthonia; (**9d**) *Obolus* sandstone at Jaggowal, about 20 miles (32.2 km.) east-southeast of Reval, Government of Esthonia; (**336n** [*de Verneuil, 1845, p. 289*]) *on Ijora (Ischora) River, Government of St. Petersburg;* (**336o**) Ungulite grit, Koporje, Government of St. Petersburg; (**336a** [Eichwald, 1860, p. 914]) *Obolus* sandstone at Podolova (Putalova?) on Ijora (Ischora) River, Government of St. Petersburg; and (**336p**) Ungulite grit, Kunitz, Government of Pskow; all in Russia.

Superfamily ACROTRETACEA Schuchert.

Family ACROTRETIDÆ Schuchert.

Subfamily ACROTHELINÆ Walcott and Schuchert.

Genus ACROTHELE Linnarsson.[a]

[ἄκρος, at the top; and θηλή, nipple.]

Acrothele Linnarsson, 1876, Bihang till K. svensk. Vet.-Akad. Handl., Bd. 3, No. 12, pp. 20–21. (Described and discussed in English as a new genus.)

Acrothele Linnarsson, Zittel, 1880, Handbuch der Palæontologie, Bd. 1, Abth. 1, p. 665. (Described in German.)

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[a] The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Acrothele* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Discina (*Orbicula*) de Verneuil and Barrande [1860, p. 532].
Obolella Billings [1862d, p. 68; 1863, p. 230].
Obolella Chapman [1863, p. 191; 1864, p. 163].
Obolella Salter [1866, p. 285].
Obolella Davidson [1868, p. 311].
Lingula Hartt [1868, p. 644].
Obolella Davidson [1871, p. 341].
Obolella Ford [1873, p. 213].
Acrotreta? White [1874, p. 6; 1877, p. 34].
Acrothele Brögger [1878, p. 76].
Lingula Hartt [1878, p. 644].
Acrothele Linnarsson [1879, p. 25].
Obolus? Barrande [1879b, Pl. CII: VII].
Acrothele White [1880, p. 41].
Discina (*Acrotreta?*) Brögger [1882, p. 47].
Acrothele? Walcott [1884b, p. 14].
Acrothele Walcott [1884b, p. 15].
Billingsia Ford [1886a, p. 467].
Elkania Ford [1886b, p. 325].
Acrothele Matthew [1886, pp. 39 and 41].
Acrotreta Walcott [1886b, pp. 107, 108, and 109].
Obolella? Walcott [1886b, p. 111].
Obolella Walcott [1886b, p. 118].
Acrothele Beecher [1891, Pl. XVII, fig. 12].
Lingula Hartt [1891, p. 644].
Acrothele Walcott [1891a, pp. 608 and 609].
Obolella Walcott [1891a, p. 612].
Obolella Hall and Clarke [1892c, p. 70].
Acrotreta Hall and Clarke [1892c, pp. 100 and 103].
Acrathele Moberg [1892b, p. 114].
Discina Miquel [1893, p. 9; 1894a, p. 106; 1894b, p. 10; 1895, p. 10].
Acrothele Matthew [1895a, p. 128, Pl. V, figs. 7a–b, and Pl. V, figs. 8a–h].
Acrothele Pompeckj [1896b, pp. 509–511 and 603].
Acrothele Matthew [1897, p. 168].
Linnarssonia Schuchert [1897, p. 262].
Acrothele Walcott [1897b, p. 716; 1898b, p. 402].
Obolella Hobbs [1899, p. 114].
Acrothele Matthew [1899b, p. 202].
Acrothele Grabau [1900, p. 615].
Linnarssonia? Walcott [1901, p. 673].
Acrothele Grönwall [1902, pp. 39 and 40].
Acrothele Matthew [1902b, pp. 396, 397, 398, 400, and 402; 1902c, p. 110].
Acrothele Walcott [1902, p. 598].
Obolella Delgado [1904, p. 364].
Acrothele Delgado [1904, p. 365].
Acrothele? Walcott [1905a, p. 303].
Acrothele Walcott [1905b, p. 11].
Acrothele Moberg and Segerberg [1906, p. 67].
Acrothele Shimer [1907, pp. 176 and 177].
Obolella Grabau and Shimer [1907, p. 189].
Acrothele Walcott [1908d, pp. 82–88].

Acrothele Linnarsson, Davidson, 1883, British Fossil Brachiopoda, vol. 5, pt. 2, pp. 213–214. (Copies description given by Linnarsson, 1876, p. 20.)

Acrothele Linnarsson, Walcott, 1886, Bull. U. S. Geol. Survey No. 30, pp. 107–108. (Copies original description [Linnarsson, 1876, p. 20] and discusses genus.)

Acrothele Linnarsson, Oehlert, 1887, Manuel de conchyliologie, by Fischer, pp. 1269–1270. (Described in French.)

Acrothele Linnarsson, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, pp. 249–250. (Described.)

Acrothele Linnarsson, Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, pp. 565–566. (Copy of preceding reference.)

Acrothele Linnarsson, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 98–101. (Copies original description, Linnarsson, 1876, p. 20, and discusses genus.)

Acrothele Linnarsson, Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 103–105. (Distribution discussed and tabulated.)

Acrothele Linnarsson, Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 200. (Described.)

Linnarssonia Grabau and Shimer?, 1907, idem, p. 200. (Described, but the only species referred to the genus (*Linnarssonia pretiosa*) is not figured, and it is impossible to tell whether the authors are discussing the *L. pretiosa* that is now referred to the genus *Acrotreta* (*Acrotreta sagittalis*), or to the genus *Acrothele* (*Acrothele pretiosa*).)

Acrothele Linnarsson, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 146. (Classification of genus.)

General form subcircular to transversely broad oval in outline. Ventral valve moderately convex to subconical; a false area is usually more or less distinctly outlined on the ventral valve between the apex (beak) and the posterior margin; pedicle opening on the posterior slope of the apex (or beneath the beak). The only suggestion of a true cardinal area is in *Acrothele bellula* Walcott (Pl. LVIII, fig. 5c); and this appears to be a broadening and slight flattening of the posterior under edge of the shell. Dorsal valve gently convex, and sometimes nearly flat; beak minute, marginal; area known only in *A. bellula* Walcott (Pl. LVIII, figs. 5f–h), where it is short and divided midway by a small, triangular false deltidium, very much as in *Acrotreta definita* Walcott (Pl. LXIV, fig. 2d.)

Surface marked by concentric lines and striæ of growth which cross the false area of the ventral valve; on some species there are low, rounded, radiating ridges that are usually confined to the ventral valve; in addition, on some species, there is a series of more or less inosculating, irregular, fine ridges with tubercles on them, which gives a highly ornamented surface such as occurs on some forms of *Micromitra* and *Westonia*.

The shells of *Acrothele* rarely exceed 13 mm. in diameter, and the average size of adult shells is from 6 to 8 mm. Substance of shell corneous. The shell is built up of several layers or lamellæ that are usually more or less obliquely inclined to the outer surface, over the central and outer portions.

The interior of the ventral valve has a small visceral area about the pedicle opening and extending a short distance in front of it; in several species an elongate depression occurs on each side and a little in advance of the pedicle opening that corresponds to the tubercle on each side of the apex of the outer surface; frequently the shell is thickened beneath the visceral cavity and a short ridge of varying width and length results; the edge of the pedicle opening may be slightly thickened, which forms a callosity or apical swelling, but not to the same extent as in the ventral valve of *Acrotreta*. Nothing has been seen of an area in front of the visceral area corresponding to the trapezoidal areas of *Obolus*, *Acrotreta*, and *Trematobolus*, in which the central, outside lateral, and middle lateral muscles were attached; in fact, it is only very rarely that the impression of the visceral area is shown. The main vascular sinuses start from just back of the pedicle opening, and curve, one on each side, out and then forward into the body of the valve, usually within a line drawn halfway between the center and the outer margin of the valve; many branches from the main sinus occur in some species. The transmedian and anterior lateral muscle scars appear to be merged in the cardinal muscle scar, situated on the outer posterolateral slope, outside of the main vascular sinuses; on one shell what appear to be the umbonal muscle scars are preserved (Pl. LXI, fig. 1c).

The interior of the dorsal valve has a median ridge of varying length and size, and main vascular sinuses that start near the posterior margin and extend directly outward for a short distance, and then obliquely forward in almost a direct line (Pl. LVI, figs. 1d and 1e; Pl. LX, figs. 1k and 1 l). The cardinal muscle scars are usually small and close to the posterolateral

margin (Pl. LX, fig. 1k), but larger scars occur and extend farther forward into the valve (Pl. LXII, fig. 1f; Pl. LVIII, figs. 3c, 3d, and 5h). The central and anterior lateral scars are situated essentially as in *Obolus;* the former on the slopes of the median ridge and the latter at the anterior end of the ridge.

Type.—Acrothele coriacea Linnarsson.

Observations.—The generic description is drawn up from the material studied in connection with the various species now referred to the genus. One of Linnarsson's species, *Acrothele granulata* [1876, p. 24] I have taken as the type of the subgenus *Redlichella* on account of the differences in the interiors of the valves.

Surface characters.—The surface characters of the various species of *Acrothele* vary nearly as much as those of *Micromitra*. The species may be grouped by the surface features under three headings: (1) Striato-granulose; (2) concentrically ridged, striated, or nearly smooth; (3) pseudopunctate.

The first group, striato-granulose or radulo-granulose, includes, as now known, sixteen species and seven varieties. The surface of the type species of the genus, *Acrothele coriacea* Linnarsson, is representative of this form of surface. It has concentric lines of growth, and a series of concentric, irregular, more or less inosculating, rounded, fine ridges upon which minute nodes or granules occur; these granules, on some species, are more or less regularly arranged on the ridges and appear over nearly the entire surface (Pl. LVI, fig. 1g), while in others they are scattered irregularly (Pl. LXI, fig. 4d). On *Acrothele matthewi* (Hartt) (Pl. LXI) and some other species the younger shells are granulated, while on the older shells the ridges are fairly regular and only an occasional granule occurs on them. On most adult shells with this form of surface the ridges near the margin are more regular and rarely inosculate. This type of surface occurs also on *Acrothele* (*Redlichella*) *granulata* (Linnarsson) (Pl. LVI, fig. 2g) and *Botsfordia granulata* (Redlich) (Pl. LVII, fig. 4r) and *Botsfordia cælata* (Hall) (Pl. LIX, figs. 1h and 1o).

The species upon which I have seen the ridges and granules are:

Acrothele avia Matthew.
avia puteis Matthew.
bergeroni Walcott.
colleni Walcott.
coriacea Linnarsson.
decipiens Walcott.
gamagei (Hobbs).
intermedia Linnarsson.
matthewi (Hartt).
matthewi eryx Walcott.
matthewi lata Matthew.
matthewi multicostata Matthew.
Acrothele panderi Walcott.
pretiosa (Billings).
prima (Matthew).
prima costata (Matthew).
proles Matthew.
quadrilineata Pompeckj.
spurri Walcott.
subsidua (White).
subsidua hera Walcott.
subsidua lævis Walcott.
yorkensis Walcott.

Acrothele bellula Walcott has this type of surface, but the ridges and granules are so minute that they are only to be seen with a very strong lens.

The second group is concentrically ridged, striated, or smooth, as far as known. I think, however, that with better-preserved specimens some of the species now included under it would be found to have the striato-granulose surface.

The species referred to it are:

Acrothele bohemica (Barrande).
borgholmensis Walcott.
ceratopygarum (Brögger).
levisensis Walcott.
maculata (Salter).
Acrothele? minuta Walcott.
Acrothele nitida (Ford).
turneri Walcott.
woodworthi Walcott.

On the pseudopunctate surface the union of the inosculating ridges is very regular and the hollows or pits between the ridges are arranged in oblique lines that appear to start on the posterolateral margins of the valves and curve obliquely forward to the opposite

side (Pl. LVII, fig. 3b). It is the same type of surface as that of *Botsfordia pulchra* (Matthew) (Pl. LXII, figs. 5, 5a–c) and *Micromitra (Iphidella) pannula* (White) (Pl. IV, figs. 1t and 1s). This form of surface is represented by only one species: *Acrothele bellapunctata* Walcott (Pl. LVII, figs. 3, 3a–b).

The surface of the following species has not been definitely determined owing to the condition of preservation. I think most of them will be found to belong to the group represented by *A. coriacea* Linnarsson (p. 642):

Acrothele dichotoma Walcott.
pr.mæva (de Verneuil and Barrande).
rara Walcott.
villaboimensis Delgado.
sp. undt. a Walcott.
sp. undt. Moberg.

The group of forms described by G. F. Matthew [1903, pp. 98–103] from the "Etcheminian" of Nova Scotia, and *A. prima* (Matthew) [1886, p. 41] from New Brunswick, and *A. prima costata* (Matthew) [1895a, p. 128], are all closely related by their general form, usually strong shells, and surface characters; the latter are variable but the range of variation is usually to be found on any large, old shell, an exception being found in radiating ridges, which vary greatly and to a certain extent depend upon conditions that affected the shell after the animal died, such as maceration and distortion by compression and movement in the embedding sediment. The shells above the horizon of the *Paradoxides* zone, represented by *Acrothele matthewi* (Hartt), appear to have been affected also by the same conditions, although the sediment is usually finer and more compact.

Pompeckj [1896b, p. 603] thought that the shell described by de Verneuil and Barrande [1860, pp. 536–537] was probably a species of *Acrothele*, and probably the same as the shell collected by Miquel. My study of Miquel's material shows that a true *Acrothele* is represented: *A. bergeroni* Walcott (Pl. LVIII, figs. 6, 6a–c). The other form is biconvex, calcareous, and not a typical *Acrothele*. I have referred to it provisionally (p. 602) as *Botsfordia? barrandei*.

Comparisons with other genera.—The relations between *Acrothele* and *Acrotreta* were recognized by Linnarsson [1876, p. 20] and by all subsequent authors who have had occasion to discuss the genus. Both genera have (a) a more or less elevated ventral valve with a pedicle opening at the summit of a more or less distinctly defined false area; (b) a moderately convex dorsal valve with somewhat similar interior markings; (c) small visceral areas in the ventral valve; (d) corneous shells built up of thin layers.

Acrothele differs from *Acrotreta* (a) in having a depressed ventral valve; (b) a faintly defined false area in the ventral valve; (c) larger size; (d) greater variety and more highly ornamented surface; (e) apparently more complex vascular markings; and (f) a difference in the position of the main vascular sinuses; for the dorsal valve this is best seen by comparing Plate LX, figures 1k and 1 l, *Acrothele subsidua* (White), with Plate LXV, figures 1f and 1g. I have examined many hundred specimens of the interior of dorsal valves of *Acrotreta* without finding any traces of the main vascular sinus, whereas in *Acrothele* they are usually present. In the ventral valve the differences are also marked, as the vascular sinuses are proportionally much larger in *Acrotreta*.

There are exceptions to the marked difference in elevation of the ventral valve, as that of *Acrothele subsidua* (White) (Pl. LX, figs. 1a, 1c, and 1d) is nearly as elevated as that of *Acrotreta sagittalis taconica* (Walcott) (Pl. LXXI, figs. 1, 1a–e).

Acrotreta appears to be a somewhat more highly delevoped form than *Acrothele*, although a smaller shell.

Geographic distribution.—Species of the *Acrothele coriacea* type occur in Sweden, Denmark, Bohemia, southern France, and Portugal in Europe; in eastern North America, in Nova Scotia and New Brunswick; in western North America in Utah, Nevada, Idaho, and Montana. This indicates the wide distribution of one specific type, and other forms extend the distribution

far to the south in the Appalachian province, *A. bellula* Walcott; and to the north in Pennsylvania, *A. yorkensis* Walcott. The general distribution of species is given in the table (p. 105) and the details of each species under the specific description.

Stratigraphic range.—*Acrothele* is represented by eight species and one variety in the upper portion of the Lower Cambrian in association with *Olenellus* or allied forms of trilobites, but in no instance has it been found low down in the Lower Cambrian. In the Middle Cambrian twenty-one species and six varieties occur, and there the genus attained its widest distribution and greatest development. One species, *A. borgholmensis* Walcott, occurs in strata of the *Ceratopyge* zone, and three species in Lower Ordovician formations. Of the latter, *A. ceratopygarum* is not a typical form of *Acrothele*. (See p. 640.)

Acrothele artemis Walcott.

Text figure 54.

Acrothele artemis Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 82, Pl. VIII, fig. 10. (Described and discussed as below as a new species. Fig. 10 is copied in this monograph as fig. 54.)

General form of ventral valve moderately convex; subcircular and somewhat obtusely acuminate in outline; apex near the posterior margin; pedicle opening unknown, but from the occurrence of a small boss on the inside of the shell beneath the apex it was probably of the same character as in closely related species.

Figure 54.—*Acrothele artemis* Walcott. A, A', Ventral valve with the apex broken. The specimen is from Locality 5b, Middle Cambrian limestones in Twomile Canyon, southeast of Malade, Oneida County, Idaho. (U. S. Nat. Mus. Cat. No. 51969.) The figure is copied from Walcott, 1908d, Pl. VIII, fig. 10.

Surface marked by concentric lines and small ridges of growth, and an irregular system of fine granules on the concentric ridges; in the lower interspaces there is an irregular distribution of very minute inosculating ridges that, with the tubercles, form a surface independent of the concentric growth lines. The shell is built up of numerous lamellæ beneath the outer surface layer and appears to have been corneous, or composed of phosphate of lime and chitin.

The largest shell has a length and width of 10 mm.; the apex is about 2 mm. from the posterior margin; dorsal valve unknown.

Observations.—This species resembles in form *Acrothele prima costata* (Matthew) (Pl. LXI, figs. 4 and 4a), and both species have a granular surface. The latter species, however, has a thinner shell, and its surface is marked by much larger granules. I know of no other closely related species.

Formation and locality.—**Middle Cambrian:** (5b) Dark blue-gray Langston limestone [Walcott, 1908f, p. 198], just above the Cambrian quartzitic sandstones, north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

Acrothele avia Matthew.

Plate LXI, figures 7, 7a–b; Plate LXII, figures 1, 1a–k.

Acrothele avia Matthew, 1899, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 3, No. 18, pp. 202–203, Pl. III, figs. 1a–h. (Described as a new species. The specimens represented by figs. 1c and 1f are redrawn in this monograph, Pl. LXI, figs. 7a and 7b, respectively.)

Acrothele avia Matthew, 1902, idem, pt. 5, No. 20, pp. 396–398, Pl. XVI, figs. 7a–b; Pl. XVII, figs. 1a–f and 2a–b. (Described and discussed. Pl. XVII, figs. 1a–f, and Pl. XVI, figs. 7a–b, are copied from Matthew, 1899b, Pl. III, figs. 1a–h. The specimens represented by figs. 2a and 2b are redrawn in this monograph, Pl. LXI, fig. 7, and Pl. LXII, fig. 1i, respectively.)

Acrothele abavia Matthew, 1902, idem, pp. 398–400, Pl. XVI, figs. 3a–d and 4a–b. (Described and discussed as a new species.)

Acrothele avia Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 55. (Notes on orientation of valves.)

Acrothele avia MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 98–99, Pl. V, figs. 1a–f and 2a–b. (Described and discussed essentially as in Matthew, 1902a, pp. 396–398. Figs. 1a–f are copied from Matthew, 1899b, Pl. III, figs. 1a–f; figs. 2a and 2b are copied from Matthew, 1902a, Pl. XVII, figs. 2a and 2b, respectively.)

Acrothele abavia MATTHEW, 1903, idem, pp. 100–101, Pl. IV, figs. 3a–d and 4a–b. (Described and discussed as in Matthew, 1902a, pp. 398–400. Figs. 3a–d and 4a–b are copied from Matthew, 1902a, Pl. XVI, figs. 3a–d and 4a–b, respectively.)

This is a strong shell of the *Acrothele matthewi* (Hartt) type. The adult shells are somewhat thicker, the surface is a little different, being coarser, and the callosity in front of the pedicle opening is longer and larger than in *A. matthewi* or its varieties. Matthew [1902a, p. 396] gives as one of the most marked distinctions of this species the presence on the sides of the dorsal valve of "about a dozen radiating, branching, crenulated ridges that extend to the margin." With all of Matthew's types before me, I find one bit of rock with two ventral valves, one partly overlapping the other; on these the radiating ridges not only occur on the sides, but also over the middle of the shell, and where a bit of the shell is broken off the ridges are clearly impressed on the cast of the interior; this specimen is labeled as one of the original types of the species; a second ventral valve preserving a part of the exterior surface also shows traces of radiating ridges. Another type specimen shows part of the exterior surface and the cast of the interior, but there is no trace of a radiating ridge on the outer surface or cast; seven specimens of the dorsal valve on which the outer layer is exfoliated show no traces of the radiating ridges. I find further that the dorsal valves on which the radiating ridges occur are very thin and hence liable to be flexed by lateral pressure, developing surface ridges on the lines of radiating striæ that occur on the inner layers of nearly all shells of *Acrothele*. On the ventral valve a few radiating ridges occur on one of the specimens (Pl. LXI, fig. 7); another specimen, laterally compressed, shows many such ridges (Pl. LXI, fig. 7a). Other specimens are without exterior traces of ridges, but when the shell is exfoliated, numerous fine, radiating striæ with stronger and deeper striæ at wider intervals are to be seen. I have taken up this matter of the radiating ridges at length, as I do not consider the side ridges on the dorsal valve of *Acrothele avia* sufficient to separate it from other species to which it is closely related.

The surface is formed of fine, irregular, concentric, rounded ridges that frequently inosculate; these ridges are crenulated by fine depressions which cross them and thus outline tubercles or rounded points of varying height and size, depending upon the depth of the radiating cross depressions; this type of surface gives great variety to different parts of the shell and to different shells. As far as I can determine by the use of a strong lens (three-quarter inch) it is essentially the same type of surface as that occurring on *Acrothele matthewi* (Hartt) and related species, one of which is shown by Plate LXI, figure 4d.

At the apex of one of the specimens of the ventral valve in Matthew's collection there are two minute elongate tubercles with a narrow depression between them, and on the posterior slope there is an oval pedicle opening with the narrow end nearest the apex; a low, narrow ridge, that divides the obscure false area midway, extends from the opening to the posterior margin.

"*Acrothele abavia*" Matthew does not appear to vary specifically from the forms of *Acrothele avia* in which the radiating ridges are absent. The specimens occur in a little coarser sediment, and on this account are not well preserved. Matthew [1902a, p. 399] speaks of a small tubercle in front of the pedicle opening and "the visceral callus that extends half of the length of the shell" of the ventral valve; such a tubercle occurs on the only two specimens of *A. avia* well enough preserved to show the interior of the ventral valve. I do not find the elongate visceral callus on any specimens of the ventral valve in Matthew's collection; some specimens do show a short callosity similar to that in *A. avia*. After a very careful study of all the specimens, also of a large collection from the same locality and strata belonging to the United States National Museum, I am led to think that Matthew mistook the median ridge of some dorsal valve in which the posterior portion was broken away as the visceral callosity of the interior of a ventral valve; this belief is further strengthened by his statement [1902a, p. 399]: "On each side of the callus a groove runs out toward the front margin. Some

examples show a median and two lateral septa in front of the callus." (See interior of dorsal valve as shown by Pl. LXII, fig. 1g.) In the United States National Museum collection, from Matthew's horizon E3a, I find 13 interiors of the ventral valve with short "callus" and 10 typical exteriors, also 22 dorsal valves. There are also fair specimens from horizons 3d and 3e. The shells of horizon 3a have the oblate form of *Acrothele avia* found at horizons 3d and 3e.

Acrothele avia differs from *Acrothele proles* Matthew in having the apex of the ventral valve a little nearer the posterior margin, but not so near as that of *Acrothele prima* (Matthew).

FORMATION AND LOCALITY.—**Middle Cambrian**: (**13d″**) Sandstones 10 feet (3 m.) below Division E2a; (**13d** and **13d′**) sandstones opposite the third waterfall in Dugald Brook, between Divisions E2a and E2b; (**10p**) sandstone just below the waterfall in Division E2b; (**131** and **131′**) sandstones of Division E3a; (**344** [Matthew, 1903, p. 81]) sandy shales of Division E3b; (**344a** [Matthew, 1903, p. 26]) sandy shales of Division E3c; (**344b** [Matthew, 1903, p. 81]) sandy shales of Division E3d; (**13n′**)[a] *sandstones of Division E3e;* and (**13n**) sandstones of Division E3f; all in Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

(**13m**) Sandstones of Division E3f of Matthew's [1903, p. 76] Etcheminian, on Gillis Brook, Indian River; and (**10p″**) sandstone on the small brook on the hill between the bridge over Indian River and McPhees Brook; both in eastern Cape Breton, Nova Scotia.

ACROTHELE AVIA PUTEIS Matthew.

Acrothele avia-puteis MATTHEW, 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 5, No. 20, p. 398, Pl. XVI, figs. 5a–b. (Characterized as a new variety.)

Acrothele avia-puteis MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 100, Pl. IV, figs. 5a–b. (Characterization and figures copied from preceding reference.)

This seems to be a variety of *Acrothele avia* Matthew. It differs in the possession of a pair of pits, one of which lies on each side of the space between the foramen and the visceral callus, partly overlapping each. The visceral callus is quite short in this form and has but little prominence. The ridges on the surface of the shell are more regularly concentric than in the type, and more sharply cut; about ten are found in the space of 1 millimeter. The cardinal area is curved forward toward the top, and finely striated. The foramen is about a fifth of the length of the valve from the cardinal line, and the front of the callus about a third. Vascular trunks and branches are visible on the surface of the ventral valve as in *A. avia.* The dorsal valve does not sensibly differ from that of *A. avia.*

The largest valve seen was 8 mm. long and about the same width.

The typical specimens of the ventral valve of *Acrothele avia puteis* are slightly different from those of *Acrothele avia,* but not sufficiently so to show clearly in an illustration. The pits beside the median line, between the pedicle aperture and the visceral callosity, do not appear in the specimens of the species, and indeed the condition of the material is such that probably they could not be distinguished if originally present. The visceral callosity is shorter and much like that of *Acrothele matthewi* (Hartt).

FORMATION AND LOCALITY.—**Middle Cambrian**: (**13m**) Sandstones of Division E3f of Matthew's [1903, p. 76] Etcheminian, on Gillis Brook; and (**344e** [*Matthew, 1903, p. 100*]) *sandy shales of Division E3d of Matthew's Etcheminian, on Gregwa Brook;* both in the Indian River valley, eastern Cape Breton, Nova Scotia.

ACROTHELE BELLAPUNCTATA Walcott.

Plate LVII, figures 3, 3a-b.

Acrothele bellapunctata WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 82–83, Pl. VIII, figs. 9 and 9′. (Described and discussed as below as a new species. Figs. 9 and 9′ are copied in this monograph, Pl. LVII, figs. 3 and 3b, respectively.)

General form a broad transverse oval with the posterior side slightly flattened and arched upward for a short distance below the apex. Ventral valve convex near the umbo and nearly flat over the anterior portion of the valve; apex near the posterior margin. Foraminal aperture apparently at the apex above a short, not distinctly marked, false area. Ventral valve nearly flat and with the posterior margin curved downward so as to fill the space caused by

[a] **13n′** is the type locality, though the specimens in the United States National Museum collections to which that number is assigned were collected later than the type specimens.

the upward arching of the margin of the ventral valve. Surface of shell beautifully ornamented by elevated sharp oblique lines with deep interspaces that give a strongly punctate appearance to the shell; concentric undulations and ridges of growth also occur in a more or less irregular manner. The inner layers or lamellæ are marked by fine, concentric, and rather strong radiating lines. The shell is built up of numerous thin layers or lamellæ of a corneous appearance.

A slightly compressed ventral valve has a length of 5 mm. with a width of 6.5 mm. A ventral valve is 4 mm. in length with a width of 5 mm.

Observations.—This is one of the most beautifully ornamented species of the genus. Its surface is not unlike that of some varieties of *Micromitra* (*Iphidella*) *pannula* (White). In form it suggests *Acrothele* (*Redlichella*) *granulata* (Linnarsson). Nothing is known of the interior character of the valves.

FORMATION AND LOCALITY.—**Lower Cambrian**: (8v) Shales in upper portion of *Holmia kjerulfi* zone, Ringsaker, Province of Hedemarken, Norway.

ACROTHELE BELLULA Walcott.

Plate LVIII, figures 5, 5a–h.

Acrothele bellula WALCOTT, 1897, Proc. U. S. Nat. Mus., vol. 19, pp. 716–717, Pl. LX, figs. 4, 4a–e. (Described and discussed as a new species. Figs. 4, 4a–e are reproduced (with slight changes) in this monograph, Pl. LVIII, figs. 5, 5a, 5c, 5f–h, respectively.)

General form transversely broad oval, with the posterior margin slightly transverse. Ventral valve slightly conical with the apex between the posterior seventh and eighth of the length of the valve; the slope from the apex to the posterior margin is about 45° and to the front at a low angle after passing from the steeper slope adjoining the apex. On each side of the apex there is an elongate, sharp tubercle, and just back, a minute pedicle opening. A slightly outlined triangular false area begins at the pedicle opening and extends to the posterior margin; it is divided by a faint, narrow, rounded ridge. Dorsal valve moderately convex, with the umbo broad, and beak at the posterior margin.

The exterior surface is marked by concentric lines of growth that cross the area of the ventral valve. The ventral valve has numerous low, narrow, obscure radiating ridges, and an extremely minute series of irregular, concentric, inosculating elevated lines that give the surface a roughened appearance under a strong lens.

Substance of the shell in appearance corneous. The largest shell in the collection is represented by a dorsal valve; this has a length of 6 mm.; width, 7 mm.

The casts of the interior of the ventral valve are very good; they show that the shell was thick over the umbo, that the cast of the pedicle opening was cone-shaped (Pl. LVIII, fig. 5b), and that on each side just in front of the base of the opening there was a short, narrow depression corresponding in position to the tubercles on the outer surface. Back of the cast of the opening the false area is rather strongly defined, also the cast of the hollows occupied by the cardinal muscles; the main vascular sinuses originate just back of the pedicle opening and arch forward toward the anterolateral margins of the shell (Pl. LVIII, fig. 5e); usually they have left no impression on the shell in advance of the visceral area; the visceral area is short and fairly well defined on some specimens (fig. 5d). Nothing is known of the muscle scars of the ventral valve except the position of the cardinal scars.

The cast of the interior of the dorsal valve is most interesting, as a true area similar to that of *Acrotreta definita* Walcott (Pl. LXIV, fig. 2d) and *Acrotreta kutorgai* Walcott (Pl. LXV, fig. 3j) is clearly shown; the area is short and divided midway by a triangular space, the lateral, slightly elevated sides of which project a little into the valve beyond the front margin, very much as in *Obolella atlantica* Walcott (Pl. LV, fig. 1e) and *O. crassa* (Hall) (Pl. LIV, fig. 2g). A median ridge extends from in front of the area to the anterior third of the valve; it has a narrow, low, median septum on its posterior half, and two central muscle scars (h) on its outer slopes a little back of the center of the valve; the anterior lateral muscle scars (j) are a little in

advance of the centrals, close to the median ridge and smaller than the centrals; the main vascular sinuses are very faint beyond where they come forward into the body of the valve; back toward the posterolateral margin of the valve small cardinal scars occur at about the same distance from the center of the area as the central scars are in front of it.

Observations.—This species is so strongly marked in its ventral valve by the pointed tubercles beside the apex, the cone-shaped pedicle passage through the shell, and distinct visceral area, and in the dorsal valve by a well-defined area and small cardinal muscle scars far out on the cardinal slope, that it can not readily be confused with any known species.

Formation and locality.—**Middle Cambrian**: (94x) Shales 0.06 mile (0.1 km.) south of Givens Mill, Cowan Creek, about 8 miles (12.8 km.) southeast of Center; and (90x) *in and attached to the outer surface of siliceous nodules in the Conasauga ("Coosa") shale, Coosa Valley, east of Center;* both in Cherokee County, Alabama.

Acrothele bergeroni Walcott.

Plate LVIII, figures 6, 6a–c.

La Discina Miquel, 1893, Note sur la Géologie des Terrains Primaires du Département de l'Hérault, St. Chinian à Coulouma, p. 9. (Mentioned in French.)

La Discina Miquel, 1894, Bull. Soc. d'Étude Sci. Nat. Béziers for 1893, Mém. Compt. Rend. des Séances, vol. 16, 1894, p. 106. (This article is a copy of the preceding reference which was published as a separate.)

La Discina Miquel, 1894, Note sur la Géologie des Terrains Primaires du Département de l'Hérault, le Cambrien et l'Arenig, p. 10. (Mentioned in French.)

La Discina Miquel, 1895, Bull. Soc. d'Étude Sci. Nat. Béziers for 1894, Mém. Compt. Rend. des Séances, vol. 17, 1895, p. 10. (This article is a copy of the preceding reference which was published as a separate.)

Acrothele Pompeckj (in part), 1896, Jahrb. K.-k. geol. Reichsanstalt for 1895, Bd. 45, Hft. 3, p. 603. (Discussed in German, changing generic reference; see under *Botsfordia? barrandei*, p. 603, for copy.)

Acrothele bergeroni Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 83–84, Pl. VIII, fig. 11. (Described and discussed as below as a new species. Fig. 11 is copied in this monograph, Pl. LVIII, fig. 6c.)

All the specimens representing this species are flattened by compression in the argillaceous shale, also more or less distorted. The outline of figure 6 (Pl. LVIII) is probably the nearest the original outline of the ventral valve, and figure 6c of the dorsal. A ventral valve 6 mm. in length has the apex 1.5 mm. from the posterior margin. A cast of the interior of a ventral valve (Pl. LVIII, fig. 6b) indicates a relatively large interior opening for the pedicle tube; a short, small visceral cavity with the shell thickened so as to form a short ridge; and an obscure false area; also that the posterior margin is arched slightly above the plane of the margin of the valve. An exterior cast shows the impression of a minute elongate tubercle on each side of the apex, and a small pedicle opening just back of them. A cast of the interior of a dorsal valve shows a short median ridge, and the posterior portion of the main vascular sinuses.

The exterior cast shows that the surface was marked by small concentric ridges and lines of growth, a few low, obscure, rounded, radiating ridges, and fine granulations or tubercles on very minute, irregular, more or less inosculating concentric ridges, or the same type of surface as that of *Acrothele coriacea* Linnarsson. If these shells were found at the same horizon in Sweden as *A. coriacea* I think they would be referred to that species except that the apex of the ventral valve of the French species is much nearer the posterior margin; more perfect specimens would probably show other differences.

This species appears to differ from *Acrothele quadrilineata* Pompeckj and *A. bohemica* (Barrande) by the more anterior position of the apex of the ventral valve.

In response to a request for permission to study the Cambrian brachiopods that he had collected from Montagne Noire, Mr. Miquel very courteously sent me a number, and among them I found this species, and, with his permission, have described it.

It gives me pleasure to give the specific name in recognition of the discovery by Prof. J. Bergeron of the Middle Cambrian fauna of Hérault, and his fine work on the fauna.

Formation and locality.—**Middle Cambrian**: (342 [Miquel, 1893, p. 9]) Shales in Montagne Noire, Coulouma, Department of Hérault, France.

Acrothele bohemica (Barrande).

Plate LVII, figures 1, 1a–d.

Obolus? bohemicus Barrande, 1879, Système silurien du centre de la Bohême, vol. 5, pt. 1, Pl. CII, figs. VII: 1–3. (Not described, but figured as a new species. Figs. VII: 1–2 are reproduced in this monograph, Pl. LVII, figs. 1 and 1a, respectively.)

Acrothele bohemica (Barrande), Walcott, 1886, Bull. U. S. Geol. Survey No. 30, p. 107. (Merely changes generic reference.)

Acrothele bohemica (Barrande), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 101. (Suggests refereuce to *Acrothele*.)

Acrothele bohemica (Barrande), Pompeckj, 1896, Jahrb. K.-k. geol. Reichsanstalt for 1895, Bd. 45, Hft. 3, pp. 509–511, Pl. XIV, figs. 7–15. (Described and discussed in German. Figs. 8b, 11b, and 10b are reproduced in this monograph, Pl. LVII, figs. 1b, 1c, and 1d, respectively.)

Barrande did not publish a description of this species, but Pompeckj [1896b, p. 509] gives an extended description based on a large number of specimens. From this and the accompanying illustrations it appears that the general form is much like that of *Acrothele coriacea* Linnarsson. It differs from the latter in having the apex nearer the posterior margin and in having a concentrically striated surface and undulating lines instead of granulose surface; these characters also distinguish *A. bohemica* from *A. (Redlichella) granulata* (Linnarsson). The student should carefully examine the series of figures accompanying Pompeckj's description as well as those of Barrande. Copies of the latter are inserted on Plate LVII, figures 1 and 1a, and copies of Pompeckj's figures on Plate LVII, figures 1b, 1c, and 1d.

The posterior position of the apex of the ventral valve suggests in this respect *Acrothele prima* (Matthew) (Pl. LXI, fig. 6) and *Acrothele prima costata* (Matthew) (Pl. LXI, figs. 4 and 4a), but in surface characters and outline of the valves the species differ, as indeed they do in the apex of *A. prima* being nearer the margin than that of *A. bohemica*. Comparison should be made with *A. quadrilineata* Pompeckj, which is closely allied to this species.

The specific name is derived from Bohemia.

Formation and locality.—**Middle Cambrian:** (**345** [Pompeckj, 1896b, p. 509]) Greenish shale in the *Paradoxides* zone, on the Dlouhá Hora, above the brook of Sbirov, near Skrej; (**345a** [Pompeckj, 1896b, p. 511]) shales in the *Paradoxides* zone, on the right bank of the brook of Karásek, near Tejřovik; (**345b** [Pompeckj, 1896b, p. 511]) in the "Bande de Jinec," at Felbabka and Jinec; and (**345c**) *in Étage C [Barrande, 1879b, Pl. CII], at Mleschitz;* all in Bohemia, Austria-Hungary.

Acrothele borgholmensis Walcott.

Plate LXIII, figures 2, 2a–b.

Acrothele borgholmensis Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 84–85, Pl. VIII, fig. 12. (Described and discussed as below as a new species. Figs. 12 and 12′ are copied in this monograph, Pl. LXIII, figs. 2 and 2a, respectively.)

General form subcircular to broad oval. Ventral valve subconical, with the apex a short distance back of the center. A clearly defined false area extends from the apex to the margin; it is defined by a slight depression and a low ridge at the outer edges; two or three longitudinal lines extend to the margin, and the concentric lines of growth of the shell cross it without interruption. An elongate, small foraminal aperture occurs just back of and beneath the apex.

The outer surface of the shell is of a dull, dark color, and marked by slightly undulating, clearly defined, concentric striæ; the inner layers are marked by fine radiating and concentric lines. The shell is built up of thin lamellæ arranged in concentric layers that are slightly oblique to the surface layer. Shell substance corneous. Nothing is known of the interior of the valves except the sharp median ridge of the dorsal valve.

The largest specimen has a diameter of 4 mm.; the average size is about 3 mm.

Observations.—The convexity, position of the apex, and clearness of the false area depend upon the degree of compression and distortion the shells have received. I have described what appears to be the uninjured shell.

The subcentral position of the apex seems to distinguish this species. It is associated with *Obolus (Bröggeria) salteri* (Holl) and *Lingulella lepis* (Salter).

The specific name is derived from Borgholm, the type locality.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**310d**) *Ceratopyge* slate at Borgholm, Oeland Island, Sweden.

ACROTHELE CERATOPYGARUM (Brögger).

Plate LXIII, figures 1, 1a–c.

Discina (Acrotreta?) ceratopygarum BRÖGGER, 1882, Die silurischen Etagen 2 und 3, p. 47, Pl. X, figs. I, 1a–b. (Described in German. Figs. 1a and 1b are reproduced in this monograph, Pl. LXIII, figs. I and 1a, respectively.)

Acrothele ceratopygonum WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 598. (Mentioned in discussion of *Acrotreta seebachi*.)

Acrothele ceratopygarum (Brögger), MOBERG and SEGERBERG, 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), p. 67. (Mentioned in Swedish.)

Acrothele barbata MOBERG and SEGERBERG, 1906, idem, pp. 67–68, Pl. III, figs. 7–10. (Described and discussed in Swedish as a new species.)

Ventral valve conical, with eccentric apex. False area well defined and marked midway by a narrow, slightly elevated ridge that does not extend quite to the margin of the shell; on the interior of the shell a narrow furrow extends nearly to the margin where it is cut off by a transverse ridge just within the margin. Foraminal aperture minute, situated at the top of the false area just below the apex; in the exfoliated shell it appears to be elongate. The outer surface of the shell appears in a cast to be nearly smooth; the inner layers or lamellæ are marked by fine concentric and radiating lines. A cast of the interior shows a very small visceral area just in front of the apex, and a cardinal muscle scar on each side of the median line back of the cast of the foraminal opening. The two ventral valves measure 5 mm. in diameter; height, about 2 mm.

From Moberg and Segerberg's description [1906, p. 67] of the dorsal valve of *Acrothele barbata* the following is taken: "The dorsal valve is nearly flat, or with the posterior and central parts slightly arched; beak marginal." The interior shows a few traces of muscle scars. The interior of the ventral valve shows the main vascular sinuses and branches very much as in *Acrothele coriacea* Linnarsson (Pl. LVI, figs. 1a, 1d). These authors give the dimensions of one of the larger shells as, length, 5.25 mm.; width, 6 mm.; elevation, 1.5 mm.

Observations.—Through the courtesy of Doctor Brögger I have had the opportunity of studying the type specimens of this species. One of them is illustrated (Pl. LXIII, fig. 1c), and I have also copied two of Brögger's figures. The species is related to *Acrothele borgholmensis* Walcott from the *Ceratopyge* slate, but differs in the character of the false area and median ridge of the latter. It is also a larger and more convex form.

Specimens from Vestfossen, Norway, one of which is illustrated on Plate LXIII, figure 1b, have the same form as the shells described by Moberg and Segerberg under the name of *Acrothele barbata* [1906, p. 67], and I find bits of the outer shell showing the "coarse, irregular, anastomosing, concentric ridges" characteristic of *Acrothele barbata;* a little trace of the marginal fringe is also shown on one specimen. The fact that the two species occur at the same stratigraphic horizon in Sweden and Norway, and the fact that they have the same specific characters, lead me to place *A. barbata* as a synonym of Brögger's *A. ceratopygarum.*

This species derives its specific name from its occurrence in the *Ceratopyge* limestone.

FORMATION AND LOCALITY.—**Passage beds** between the Upper Cambrian and the Ordovician: (**323h** [*Brögger, 1882, p. 17*]) *blue Ceratopyge limestone, at Vestfossen, 10 miles (16.1 km.) west-southwest of Christiania, Norway.*

(**310** [Moberg and Segerberg, 1906, p. 67]) *Ceratopyge* limestone (zone 4), at Ottenby, on Oeland Island, Sweden.

ACROTHELE COLLENI n. sp.

Text figures 55A–E, page 641; Plate LXIII, figures 6, 6a–b.

This species is represented by numerous specimens of both valves, but only the exterior of the valves is known. The ventral valve is subconical, with the apex a little in front of the

posterior third; the slope from the apex to the posterior margin is about 45° and that to the anterior margin 20°. The posterior slope is marked by a rather clearly defined false area, which is slightly flattened, and marked midway by a very slight depression; the apical opening is small, oval in outline, and situated on the posterior side of the apex. On finely preserved specimens the front and sides of the apical opening have a narrow, slightly elevated ridge, and a trace of a small tubercle on each side at the anterior end of the opening; the posterior margin arches very slightly beneath the false area. The dorsal valve is moderately convex, and most prominent on the umbo, with the apex at the posterior margin.

One of the largest ventral valves has a length of 9 mm.; width, 10 mm. The dorsal valve has a length of 7 mm.; width, 8 mm. These proportions vary somewhat as the shells are more or less distorted by compression in the shale. Shell substance corneous.

The exterior surface is marked by very fine, concentric ridges of growth, with depressed and elevated lines between them; there are also numerous low, rounded, narrow, radiating ridges that vary in strength and number on different specimens; on some shells there is hardly a trace of the radiating ridges, and on others they are numerous, especially on the sides; one dorsal valve shows nine on each side, with a few scattered through the central portion in addition to the concentric and radiating lines; there is also a system of exceedingly minute and irregular, more or less inosculating, but, as a whole, concentric ridges, upon which very minute tubercles occur. These are most perfect over the posterior half of the shell, but extend in many examples to the front margin.

A cast of the apical portion of the dorsal valve shows that the pedicle aperture enlarged as it passed through the shell, and that the visceral area was short.

Observations.—This species is of the *Acrothele coriacea* Linnarsson type. It has the same surface, except that the irregular, concentric ridges and tubercles are finer.

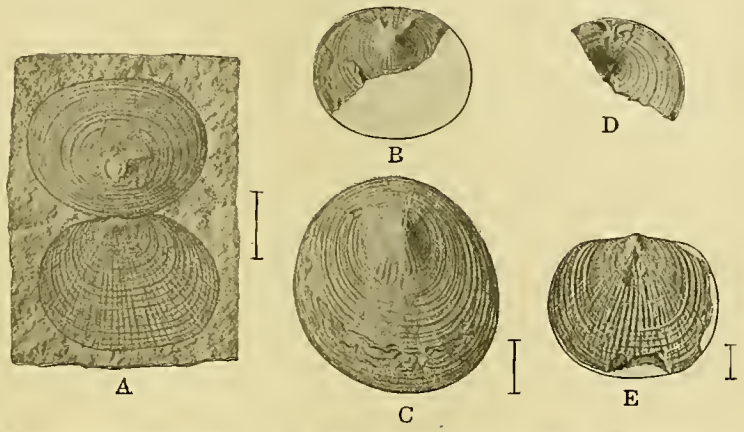

FIGURE 55.—*Acrothele colleni* n. sp. A, Slab showing a ventral and a dorsal valve (U. S. Nat. Mus. Cat. No. 51410a). B, Broken ventral valve showing false area (U. S. Nat. Mus. Cat. No. 51410b) (× about 4). C, A much larger ventral valve than that represented by B (U. S. Nat. Mus. Cat. No. 51410c). D, Cast of a ventral valve showing the incurving of the flexure lines across the false area (U. S. Nat. Mus. Cat. No. 51410d) (× about 4). E, Dorsal valve (U. S. Nat. Mus. Cat. No. 51410e).

The specimens represented are from Locality **35c**, a drift block of Lower Cambrian shales, on the slopes of Mount Bosworth, on the Continental Divide, 1 mile (1.6 km.) east of Hector, British Columbia.

The Lower Cambrian specimens from British Columbia appear to be identical with those from Montana and they are associated with the same subfauna, of which *Albertella helena* Walcott is considered to be typical. The shells from the Middle Cambrian, which occur 2,450 feet higher in the section on Mount Stephen, have the same form and surface markings and appear to be identical in all respects. It is interesting to note that *Micromitra (Iphidella) pannula* (White) has a similar vertical range.

The specific name is given for Mr. M. Collen, of White Sulphur Springs, Montana, who collected the finest specimens at the locality on Scapegoat Mountain, Montana.

FORMATION AND LOCALITY.—**Middle Cambrian: (14s)** About 2,300 feet (701 m.) above the Lower Cambrian and 2,700 feet (823 m.) below the Upper Cambrian, in the *Ogygopsis* zone of the Stephen formation [Walcott, 1908f, p. 210], on the northwest slope of Mount Stephen, above Field on the Canadian Pacific Railway, British Columbia, Canada.

(**4q**) *About 315 feet (96 m.) above the unconformable base of the Cambrian and 190 feet (57.9 m.) above the top of the quartzitic sandstones, in a shale which corresponds in position to the upper part of shale No. 6 (Lower Cambrian) of the Dearborn River section [Walcott, 1908f, p. 202] on the ridge between Gordon and Youngs creeks, about halfway between Gordon Mountain and Cardinal Peak, Ovando quadrangle (U. S. Geol. Survey), Powell County, Montana.*

Lower Cambrian: (57e) About 115 feet (35 m.) below the Middle Cambrian, in limestone correlated with the top of 1c of the Mount Whyte formation on Mount Bosworth [Walcott, 1908f, p. 213], just above the tunnel on the north shoulder of Mount Stephen, about 3 miles (4.8 km.) east of Field, British Columbia; (35c) drift blocks supposed to have come from the Mount Whyte formation [Walcott, 1908f, p. 214], found on the south slope of Mount Bosworth, a short distance northwest of the Canadian Pacific Railway track between Stephen and Hector, eastern British Columbia; and (35e) about 270 feet (82.3 m.) below the Middle Cambrian, in a greenish siliceous shale correlated with No. 3 of the Mount Whyte formation on Mount Bosworth [Walcott, 1908f, p. 214], in the amphitheater between Popes Peak and Mount Whyte, about 3 miles (4.8 km.) northwest of Lake Louise, southwest of Laggan on the Canadian Pacific Railway, Alberta, Canada.

(4v) About 200 feet (61 m.) above the unconformable base of the Cambrian and 75 feet (22.9 m.) above the top of the quartzitic sandstones, in a shale which corresponds in stratigraphic position to shale No. 6 of the Dearborn River section [Walcott, 1908f, p. 202], on Gordon Creek, 6 miles (9.6 km.) from South Fork of Flathead River, Ovando quadrangle (U. S. Geol. Survey), Powell County, Montana.

Acrothele coriacea Linnarsson.

Plate LVI, figures 1, 1a–i.

Acrothele coriacca Linnarsson, 1876, Bihang till K. svensk Vet.-Akad. Handl., Bd. 3, No. 12, pp. 21–23, Pl. IV, figs. 44–48. (Described and discussed in English as a new species.)

Acrothele coriace Linnarsson, Brögger, 1878, Nyt Magazin for Naturvidenskaberne, Bd. 24, Hft. 1, p. 76, Pl. IV, fig. 11. (Mentioned.)

Acrothele coriacca Linnarsson, Grönwall, 1902, Danmarks geol. Undersøgelse, Række 2, No. 13, p. 40. (Localities mentioned in Norwegian.)

General form subcircular to transversely broad oval in outline, with the posterior margin slightly transverse. Ventral valve slightly conical with the apex usually within the posterior fourth of the distance from the front to the back margin. The apex, as usually seen, is formed of two minute, elongated tubercles with a narrow, elongate depression between them; at the posterior end of this depression a minute pedicle aperture occurs; on some shells the two minute tubercles unite in front so as to form a ring with a break at the back side just behind which the pedicle aperture opens. The size of the tubercles and median depression varies in different shells, and also with the amount of exfoliation of the outer shell. In some examples when the shell is nearly all exfoliated at the apex and umbo the two tubercles are prominent and a third tubercle occurs back of them which is the cast of the inner portion of the foraminal tube. A narrow false area is faintly defined on some shells and more distinctly on others. A median line often extends from the foraminal aperture to the margin. Casts of the interior show a much more distinctly defined false area, also that it is impressed in the shell. The striæ of growth cross the area without interruption except as they curve slightly upward at the center on some shells. Linnarsson [1876, p. 21] states that there is no trace of a longitudinal groove as in *Acrotreta subconica* Kutorga; this is true of most specimens, but on others from the *Paradoxides forchhammeri* zone, I find a narrow line and on others a curving upward of the concentric striæ at the median line. The dorsal valve is slightly convex near the umbo, from which it curves rather abruptly down to the posterior margin and in some shells the lateral and anterior margins curve up a little, leaving a slightly concave surface between the margins and the umbo. The apex is near the posterior margin; it is divided midway by a narrow furrow so as to form a narrow elongate tubercle on each side. On some shells a slight depression or flattening extends to about the middle of the valve.

The exterior surface is marked by concentric lines and striæ of growth and slight undulations or ridges on the older shells; a few rather faintly indicated, radiating costæ occur on some examples of the ventral valve. Linnarsson [1876, p. 21] describes the outer surface as being rough, somewhat like leather. With a strong magnifier I find this to be caused by a minute granulation on fine, irregular, slightly elevated striæ. The shiny inner layers of the shell are marked by concentric lines and very fine radiating lines.

The shell is corneous and built up of numerous thin layers or lamellæ so as to form a shell that is strong at the umbo and thin toward the margins. The largest ventral valve in

the material available has a length of 8 mm. and a width of 10 mm. The average size is from 5 to 6 mm. in length, with a greater width.

The interior of the ventral valve shows a rounded, slightly depressed visceral area, which forms a semicircular area about the well-defined apical callosity and pedicle opening; back of the latter the false area is usually clearly defined. From each side and a little back of the pedicle opening in the ventral valve a rather strong main vascular sinus arches outward and then forward to the anterior half of the valve, where it divides into two or more branches; numerous lateral sinuses branch off and extend nearly to the margin, and a few shorter branches extend toward the central section. In the dorsal valve the vascular markings include the main vascular sinuses, which extend obliquely forward and outward, and an elaborate series of canals that originate in advance of the visceral area (Pl. LVI, figs. 1d and 1f).

Our information as to the muscle scars of the ventral valve is limited to a suggestion of small cardinal scars on each side of the false area a little back of the main vascular sinuses. In the dorsal valve small cardinal scars (cl) occur on each side of the median ridge back of the base of the main vascular sinuses; small centrals (h) also occur on each side near the anterior end of the median ridge.

Observations.—The above description is made from the study of a large number of specimens from several localities in Sweden, and a fine locality on Bornholm Island, Denmark. It differs somewhat from Linnarsson's [1876, p. 21], chiefly as the result of my having more and somewhat better preserved material for study. He describes an umbonal muscle scar in the dorsal valve, but from his illustration [1876, Pl. IV, fig. 48b] I am inclined to think that the scar is only a bit of the false area, the inner shell having been exfoliated.

The relations of the species are with *Acrothele* (*Redlichella*) *granulata* (Linnarsson), from which it differs in smaller average size, more finely granulated surface, and, what is of more value, in the form of the muscle scars of the dorsal valve.

This type of *Acrothele* is widely distributed. It is represented in Bohemia by *A. bohemica* (Barrande) and *A. quadrilineata* Pompeckj; in France by *A. bergeroni* Walcott; in North America by *A. matthewi* (Hartt) and its varieties; and in China by *A. matthewi eryx* Walcott.

Formation and locality.—**Passage beds** between the Upper Cambrian and the Ordovician: (**8x**) Limestone at Slemmestad, about 3 miles (4.8 km.) southwest of Christiania, Norway.

Upper-Middle Cambrian: (**310i**) Passage beds between the Middle Cambrian *Paradoxides forchhammeri* zone and the Upper Cambrian *Olenus truncatus* zone at Borgholm, Oeland Island, Sweden.

Middle Cambrian: [a] (**16h** and **334h**) Limestones of *Paradoxides forchhammeri* zone at Borregaard; (**16 l**) limestones of *Paradoxides davidis* zone at Borregaard; (**334b**) [b] Andrarum limestone at Borregaard; (**334e**) [b] in the *Paradoxides tessini* zone at Borregaard; (**334d**) [b] in the zone with *Agnostus parvifrons* at Borregaard; (**334f**) limestone on Bornholm Island; (**16j**) limestone of *Paradoxides forchhammeri* zone at Laesaå; (**16k**) limestones of *Paradoxides davidis* zone at Laesaå; (**334e**) Andrarum limestone at Laesaå; all on Bornholm Island, Denmark.

(**8w**) Limestones of the *Paradoxides forchhammeri* zone, at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad; (**320o**) [c] limestone band between the *Holmia kjerulfi* zone and the *Paradoxides tessini* zone at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad; (**320f**) limestone at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad; (**320 l**) drift blocks from the *Paradoxides œlandicus* zone at Lillviken, near Oestersund, Jemtland; (**320m**) [c] *limestones of the Paradoxides forchhammeri zone at Kinnekulle, northeast of Lidköping, Province of Skaraborg;* (**320n**) limestones of the *Paradoxides forchhammeri* zone at Lovened, Djupadal, 19 miles (30.6 km.) south-southeast of Skara, Province of Skaraborg; (**321q**) limestones of the *Paradoxides forchhammeri* zone at Munkesten, north of Hunneberg, Province of Skaraborg; (**320r**) limestones of the *Agnostus lævigatus* zone, at Hunneberg, western boundary of the Province of Skaraborg; (**320y**) limestones of the *Paradoxides forchhammeri* zone at Gudhem, 12.5 miles (20.1 km.) south-southeast of Skara, Province of Skaraborg; (**320b**) limestone forming 2d of the *Paradoxides* zone, the *Agnostus lævigatus* horizon, at Gudhem, 12.5 miles (20.1 km.) south-southeast of Skara, Province of Skaraborg; (**320v**) [c] in the *Paradoxides forchhammeri* zone at Lanna, Hjulsta, Vinala, and Vrana, all four in Nerike; (**320p**) [c] limestones of the *Paradoxides forchhammeri* zone at Södra Möckleby, southern part of Oeland Island; (**320g**) limestones of the *Paradoxides forchhammeri* zone at Borgholm, Oeland Island; and (**320q**) limestone forming 2c of the *Paradoxides forchhammeri* zone, at Alunbruk (alum works), southern part of Oeland Island; all in Sweden.

(**324b**) Shales of Étage 1c [Brögger] at Krekling, in Sandsvär; (**324c**) shales of Étage 1d at Krekling, in Sandsvär; and (**324a**) shale of Étage 1c [Brögger] at Skrena, Skiensdalen; all [Christiania Univ. Min. Inst. Coll.] in Norway.

[a] This species also occurs in Locality **320k**. [b] Grönwall, 1902, p. 40. [c] Linnarsson, 1876, p. 23.

Acrothele decipiens Walcott.

Plate LVIII, figures 3, 3a–d.

Acrothele decipiens Walcott, 1897, Proc. U. S. Nat. Mus., vol. 19, p. 716, Pl. LX, fig. 2. (Described and discussed as a new species. The specimen represented by fig. 2 is redrawn in this monograph, Pl. LVIII, fig. 3a.)

General form of the ventral valve subcircular, usually a little longer than wide; moderately convex; apex at the posterior one-sixth to one-eighth of the valve. Pedicle aperture of medium size, situated on the posterior slope of the summit of the apex; the slope from the apex to the posterior margin is rather abrupt; and very gentle to the front margin. The obscure false area, with a faintly defined groove down its center, is shown on some specimens. Dorsal valve oval, moderately convex, and marked by a shallow depression extending from the back to the front; apex marginal.

Surface marked by fine, concentric lines of growth, and very fine, somewhat irregular, and sometimes inosculating ridges upon which occur exceedingly minute tubercles which give a very finely tuberculated surface; some specimens show depressed, narrow, rounded ridges extending from near the apex to the margins; these ridges vary in size and number. Shell substance corneous.

Nothing is known of the interior of the ventral valve except a cast of the apical callosity (Pl. LVIII, fig. 3a). The interior of the dorsal valve has a strong median ridge that extends forward beyond the center, and strong cardinal scars.

Observations.—This species is of the *Acrothele matthewi* (Hartt) type. It has a similar surface, and the apex of the ventral valve is well toward the posterior margin. The interior of the dorsal valve suggests that of *Acrotreta* more than do most interiors of the dorsal valves of *Acrothele*. It has an unusually long and strong median ridge and cardinal muscle scars.

Acrothele decipiens was found associated with fragments of *Olenellus* in the fine gray limestone in the Lower Cambrian shale.

Formation and locality.—**Lower Cambrian:** (**50**) *Shaly limestones, 1.125 miles (1.8 km.) north of Stoner, 10 miles (16.1 km.) east-northeast of York;* and (**346**) limestone and shale a little south of Emigsville; both in York County, Pennsylvania.

Acrothele dichotoma Walcott.

Plate LX, figure 2.

Acrothele? dichotoma Walcott, 1884, Mon. U. S. Geol. Survey, vol. 8, pp. 14–15, Pl. IX, fig. 11. (Described and discussed as a new species. The specimen represented by fig. 11 is redrawn in this monograph, Pl. LX, fig. 2.)
Acrotreta dichotoma Walcott, 1886, Bull. U. S. Geol. Survey No. 30, p. 107. (Suggests reference to *Acrotreta*.)
Acrotreta dichotoma (Walcott), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 100 and 103. (Mentioned.)

Shell of medium size, thin, corneous, nearly circular in outline, the transverse diameter being a little greater than the longitudinal. Ventral valve depressed, discoid, with the apex but slightly elevated above the general plane of the surface and situated about one-third the distance from the posterior to the anterior margin. The apex is exfoliated, but the inner layers show that it was perforate and that in the interior the shell was thickened about the pedicle opening. The slightly depressed area is triangular in form, and extends to the posterior margin, gradually expanding to a width of a little less than its length; it appears to have been quite minute at first, just beneath the apex, and to have been filled in by successive additions of the shell, so that the generally circular outline of the shell has scarcely been broken by the very slight truncation of the posterior margin. The additions to the posterior margin of the false area are crowded together as little transverse ridges with fine striæ between.

The outer portion of the shell is largely exfoliated, but traces of radiating striæ and concentric lines of growth are shown. The latter on the outer portion appear to have been continuous with those crossing the pseudodeltidium. From each side of the apex a narrow, main vascular sinus gently diverges, extending toward the central portion of the shell. Transverse diameter, 7.5 mm.; longitudinal diameter, 6.75 mm.; elevation or convexity, about 0.75 mm.

When describing this species in 1884 I was not aware that a false area was present on some ventral valves of the type species of the genus, and that the supposed muscle scars were the main vascular sinuses. This caused me to question the generic reference.

The ventral valve of *Acrothele dichotoma* has the same general form as *A. subsidua* (White), but it has a thicker shell, and, so far as known, a concentrically striated surface.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**58**) Shaly limestone in upper beds of the Secret Canyon shale, east side of New York and Secret canyons, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

ACROTHELE GAMAGEI (Hobbs).

Plate LX, figures 5, 5a–c.

Obolella gamagei HOBBS, 1899, Am. Geologist, vol. 23, No. 2, pp. 114–115, figured. (Described, figured, and discussed as a new species.)

Acrothele gamagei (Hobbs), GRABAU, 1900, Occas. Papers Boston Soc. Nat. Hist., No. 4, vol. 1, pt. 3, pp. 615–617; fig. 48, p. 617; Pl. XXXI, figs. 1a–d. (Described and discussed. Fig. 48 is copied from the figure accompanying the preceding reference.)

Acrothele gamagei (Hobbs), SHIMER, 1907, Am. Jour. Sci., 4th ser., vol. 24, pp. 176 and 177. (New locality mentioned.)

Acrothele gamagei (Hobbs), GRABAU and SHIMER, 1907, North American Index Fossils, vol. 1, p. 200. (Characterized.)

General form subcircular to transversely broad oval in outline, with the posterior margin slightly transverse. Ventral valve slightly conical with the apex at about the posterior fifth of the length of the valve; the apex is formed of two elongate tubercles with a slight depression between them; at the posterior end of the depression a small pedicle opening occurs; back of the pedicle opening a more or less indistinctly defined false area extends to the posterior margin; the posterior margin of the valve arches slightly upward.

The dorsal valve is gently convex with posterior portion curving slightly downward so as to fit closely into the upward-curving margin of the ventral valve; beak marginal.

The surface is marked by narrow, concentric undulations of growth, a few obscurely defined, radiating ribs and fine, concentric, irregular, undulating, elevated lines; the latter have numerous minute tubercles on them over the central portions of the shell, and sometimes on the outer lines of the old shells; this results in a finely granulated surface that may be seen with the aid of a strong lens. The concentric lines cross the false area with only slight irregularity. The shell appears to be corneous and built up of several thin layers or lamellæ.

The interior of the ventral valve shows an elongate depression on each side of the apex, a small visceral area, and not very strongly defined main vascular sinuses that originate back of the pedicle opening and curve forward into the body of the valve. The interior of the dorsal valve has a low, rounded, median ridge that extends forward of the center where it bifurcates; a narrow, sharp, median septum occurs on the posterior portion of the ridge; the main vascular sinuses originate near the posterior margin beneath the beak and extend obliquely forward into the valve.

The only muscle scars seen are the elongate, oval central scars of the dorsal valve, which are situated on the slopes of the median ridge back of the transverse center of the valve.

Observations.—As stated by Grabau [1900, p. 615] this is the Massachusetts representative of *Acrothele matthewi* (Hartt) of the St. John formation of New Brunswick. With the additional information afforded by a collection made by William P. Rust for the United States National Museum, the similarity between the two forms is still more striking; they have the same general form, surface, and convexity; but *A. gamagei* attains a larger size and differs in the position of its main vascular sinuses; the latter may be seen by comparing Plate LX, figures 5b and 5c, with Plate XLI, figures 1c and 1d.

The specific name was given in honor of Miss A. O. Gamage, of South Bristol, Maine.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**326b** [*Grabau, 1900, p. 617*]) *Braintree slate, below high tide about 100 feet (30.5 m.) east of the quarry at East Braintree, Abington quadrangle (U. S. Geol. Survey)*; and (**5**) siliceous shale on Hayward Creek, Braintree, Dedham quadrangle (U. S. Geol. Survey); both in Norfolk County, Massachusetts.

Acrothele intermedia Linnarsson.

Plate LVI, figures 3, 3a–d.

Acrothele intermedia Linnarsson, 1879, Sveriges Geol. Undersökning, Afhandl. och Uppsatser, Ser. C, No. 35, pp. 25–27, Pl. III, figs. 40–44. (Described in Latin, and described and discussed in Swedish, as a new species. Figs. 40–44 are reproduced in this monograph, Pl. LVI, figs. 3, 3a–d, respectively.)

Acrothele intermedia Linnarsson, Grönwall, 1902, Danmarks geol. Undersøgelse, Række 2, No. 13, p. 39. (Localities mentioned in Norwegian.)

A comparison of the figures of *Acrothele intermedia* on Plate LVI, with those representing *A. coriacea* Linnarsson and *A. (Redlichella) granulata* (Linnarsson) on the same plate, shows very clearly that *A. intermedia* is related in form to both, but that it differs in narrowing proportionately more toward the posterior margin. Linnarsson [1879, p. 26] states that in surface characters it agrees more nearly with *A. coriacea*. The outer surface is described as having numerous fine concentric striæ without granules. He gives [1879, p. 26] the dimensions of two ventral valves as "length 8 and 6 mm., width 9.5 and 7 mm., respectively." A dorsal valve 9 mm. in length has a width of 11 mm.

I have not seen the type of this species, or found specimens of it in the collections received from Sweden. Five of Linnarsson's figures are reproduced on Plate LVI. Two of these show a somewhat different position and arrangement of the main vascular canals and branches of the ventral valve than in *A. coriacea* Linnarsson.

Formation and locality.—**Middle Cambrian**: (**16h**) Limestones of the *Paradoxides forchhammeri* zone at Borregaard; and (**334a** [Grönwall, 1902, p. 39]) limestones of the *Conocoryphe exsulans* zone at Borregaard; both on Bornholm Island, Denmark.

(**320h**) Shales in the *Paradoxides tessini* zone at Lovened, Province of Skaraborg; (**320i**) limestones of the *Coronatus* zone, at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad; (**320j**) limestones of the *Coronatus* zone, at Gislöf, Province of Malmöhus; and (**320k**) *limestones of the Coronatus zone, at Kiviks Esperöd, Province of Malmöhus;* all [Grönwall, 1902, p. 39] in Sweden.

(**320q**) Limestone forming 2c of the *Paradoxides forchhammeri* zone at Alunbruk (alum works), southern part of Oeland Island, Sweden.

Specimens that are rather doubtfully compared with *Acrothele intermedia* occur at the following locality:

Upper Cambrian: (**304j** [Mason College Coll.]) Lower Stockingford shales, Puxley Park Lane, halfway up the path to the quarry, Atherstone, Warwickshire, England.

Acrothele levisensis Walcott.

Plate LXXXI, figures 12, 12a–b.

Acrothele levisensis Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 85, Pl. VIII, fig. 13. (Described and discussed as below as a new species. Fig. 13 is copied in this monograph, Pl. LXXXI, fig. 12.)

Outline transversely broad ovate, ventral valve moderately convex at the apex, which is about the posterior fifth of the length of the valve; pedicle aperture small and situated on the slope back of and near the apex. Dorsal valve depressed convex, with a very gentle slope from the umbo to the front margin and a greater slope to the marginal beak.

Surface marked by fine concentric lines and striæ that cross the space back of the apex without apparent interruption. A compressed ventral valve 8 mm. in length has a width of 10 mm. A dorsal valve has a length of 7 mm.; width, 8 mm.

The cast of the interior of a compressed dorsal valve shows a median ridge that expands near the center of the valve, and a main vascular sinus on each side that has the same general course as in *Acrothele coriacea* Linnarsson.

Observations.—In general form this species is much like *Acrothele coriacea* and related species. It differs from them in having a smooth surface except for the concentric lines and striæ.

The four specimens representing this species were attached to a block in the collections of the Geological Survey of Canada, with specimens of *Elkania desiderata* (Billings).

The specific name is derived from Point Levis, the type locality.

Formation and locality.—**Lower Ordovician**: (**319a** [Geol. Survey Canada]) Levis shale, Point Levis, Province of Quebec, Canada.

Acrothele maculata (Salter).

Plate LVII, figures 2, 2a–b; Plate LVIII, figure 2.

Obolella maculata (Hicks MS.) Salter, 1866, Rept. British Assoc. Adv. Sci. for 1865, p. 285. (Name merely listed.)

Obolella maculata Salter, Davidson, 1868, Geol. Mag., vol. 5, p. 311, Pl. XVI, figs. 1–3. (Described as below, and discussed. Figs. 1–3 are reproduced in this monograph, Pl. LVII, figs. 2, 2a–b, respectively.)

Obolella maculata Salter, Davidson, 1871, British Fossil Brachiopoda, vol. 3, pt. 7, No. 4, p. 341, Pl. L, figs. 18–21. (Copy of preceding reference. Figs. 18, 19, and 21 are copied from Davidson, 1868, Pl. XVI, figs. 1, 2, and 3, respectively.)

Not *Obolella maculata* Delgado, 1904, Communicações Commissão Serviço Geol. Portugal, tome V, fasc. 2, p. 364, Pl. IV, fig. 24. (Described in French. This species is referred in this monograph to *Acrothele villaboimensis*.)

The description by Davidson [1868, p. 311] follows:

Shell small, transversely oval, valves moderately convex; 4 lines in length, by 5 in breadth. Beak very obtusely acuminated; front broadly rounded; greatest breadth at about the middle of the shell; surface smooth, marked only by fine concentric lines of growth. Interior incompletely known.

From the above description it is not possible to refer this species to *Acrothele*, but the figure given of the interior of the dorsal valve clearly indicates that genus. All of the figures given by Davidson appear to be of dorsal valves. It would be interesting to know if the specimens illustrated by Davidson [1871, Pl. LIX, figs. 41a, 42a] as "*Discina pileolus* Hicks" are associated with the specimens illustrated as "*Obolella maculata* Hicks" [Davidson, 1871, Pl. L, figs. 18–21].

With our present information it is difficult to make comparisons with other species of *Acrothele* further than to call attention to the similarity of the interior of the dorsal valve to that of *Acrothele subsidua* (White) (Pl. LX, fig. 1k).

Formation and locality.[a]—**Middle Cambrian:** (**318d** [Davidson, 1871, p. 341]) Sandstone in the middle portion of the Menevian at Porth-y-rhaw, St. Davids; and (**318h**) shales in the Menevian at St. Davids; both in South Wales. (**318e**) Lower portion of the Menevian, at Camlan; and (**318f**) lower portion of the Menevian at Gwynfynydd; both [Davidson, 1871, p. 341] in North Wales.

Acrothele matthewi (Hartt).

Plate LXI, figures 1, 1a–g.

Lingula matthewi Hartt, 1868, Acadian Geology, by Dawson, 2d ed., p. 644, fig. 221. (Described as a new species. The specimen represented by fig. 221 is redrawn in this monograph, Pl. LXI, fig. 1a.)

Lingula matthewi Hartt, 1878, idem, 3d ed., p. 644, fig. 221. (Copy of Hartt, 1868, p. 644.)

Acrothele matthewi (Hartt), Walcott, 1884, Bull. U. S. Geol. Survey No. 10, p. 15, Pl. I, figs. 4 and 4a. (Original description copied and species discussed. The specimen represented by fig. 4a was labeled by Hartt as "*Obolus* (*Discina*) *nitidus*," n. sp., and is redrawn in this monograph, Pl. LXI, fig. 1. Fig. 4 is drawn from the specimen figured by Hartt, 1868, p. 644, fig. 221, and is redrawn in this monograph, Pl. LXI, fig. 1a.)

Acrothele matthewi (Hartt), Walcott, 1886, Bull. U. S. Geol. Survey No. 30, p. 109. (Mentioned as similar to *Acrothele subsidua*.)

Acrothele matthewi (Hartt), Matthew, 1886, Trans. Roy. Soc. Canada for 1885, 1st ser., vol. 3, sec. 4, No. 4, pp. 39–41, Pl. V, figs. 15 and 15a. (Original description copied and species redescribed and discussed.)

Acrothele matthewi (Hartt), Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 609. (Mentioned as closely allied to *Acrothele subsidua* (White).)

Lingula matthewi Hartt, 1891, Acadian Geology, by Dawson, 4th ed., p. 644, fig. 221. (Copy of Hartt, 1868, p. 644.)

Acrothele matthewi (Hartt), Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, Pl. III, fig. 24. (Fig. 24 is drawn from the specimen figured by Matthew, 1886, Pl. V, figs. 15 and 15a.)

Acrothele matthewi (Hartt), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 99 and 100, Pl. III, fig. 29. (Discussed. Fig. 29 is copied from fig. 24 of the preceding reference.)

Acrothele matthewi (Hartt), Matthew, 1895, Trans. New York Acad. Sci. for 1894–95, vol. 14, p. 128, Pl. V, figs. 6a–b. (No text reference. Figs. 6a–b are copied from Matthew, 1886, Pl. V, figs. 15 and 15a, respectively.)

Acrothele matthewi (Hartt), Matthew, 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 14, pt. 5, No. 20, pp. 397 and 402, Pl. XVII, figs. 5a–b. (Mentioned. Figs. 5a–b are copied from Matthew, 1886, Pl. V, figs. 15 and 15a, respectively.)

Acrothele matthewi (Hartt), Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 104, Pl. V, figs. 5a–b. (Mentioned. Figs. 5a–b are copied from Matthew, 1902a, Pl. XVII, figs. 5a–b, respectively.)

[a] The type locality is unknown. Davidson's figure 3 [1868, Pl. XVI] has been designated as the type, but its locality is unknown.

Acrothele matthewi (Hartt), Grabau and Shimer (in part), 1907, North American Index Fossils, vol. 1, p. 200, fig. 234f (not 234g). (Described. Fig. 234f is copied from Matthew, 1886, Pl. V, fig. 15; fig. 234g from Matthew's figure, 1895a, Pl. V, figs. 7a–b, of *Acrothele matthewi prima*, now referred to *Acrothele prima*.)

General form subcircular to transversely broad ovate in outline, with the posterior margin slightly transverse. Ventral valve subconical in young shells, becoming depressed, with an elevated apex in the adult stages of growth. The apex is within the posterior fourth of the valve, usually about one-sixth the distance from the posterior to the front margins; it is formed of two minute, more or less elongated tubercles, with a depression between them at the posterior end of which a minute pedicle opening occurs; a specimen of the variety *Acrothele matthewi multicosta* Matthew shows a minute tubercle just back of the pedicle opening that looks as though it were part of a ring that formerly extended about the apex, the two side tubercles being other portions of the ring. A narrow false area is indicated on some shells; on others it is absent.

Dorsal valve slightly convex on the umbo, and nearly flat over the anterior portions; apex marginal as far as can be determined from the compressed shells. The exterior surface is marked by concentric lines and striæ of growth and a few laminated ridges near the outer margins; on some specimens of the ventral valve one or two low, obscure ridges extend forward from the apex to the front margin. The epidermal layer is also marked by fine granulations or papillæ that are thickly placed over the surface; on the outer portions the granules are closely spaced on the top of low, irregular, narrow ridges in the same manner as on *Acrothele coriacea* Linnarsson; the inner layers of the shell are shiny and marked by concentric lines and very fine radiating striæ.

The shell is corneous and built up of several thin layers or lamellæ. A large ventral valve has a length of 7 mm. with a width of 8 mm.

The interior of the ventral valve shows an apical callosity penetrated by the pedicle opening, and back of it the base of the main vascular sinuses; the latter extend outward and forward to about the transverse center of the valve, and then forward, curving inward more or less; rather strong lateral branches extend outward at varying points; one specimen shows three branches and another seven branches; back of the base of the sinuses a narrow, depressed space extends to the margin of a very narrow area; these features are shown in a cast of the interior (Pl. LXI, fig. 1c); the median depressed space corresponds to the false pedicle furrow in some species of *Acrotreta* (Pl. LXV, figs. 3g, 3h). The interior of the dorsal valve has a very characteristic median septum that extends forward from one-fourth to one-half the length of the valve; also the posterior portions of the main vascular sinuses that originate in front of the beak and extend outward and then obliquely forward.

Of the muscle scars only the minute umbonal scars of the ventral valve have been observed; these are minute and close to the anterior end of the false pedicle furrow.

Observations.—In general form and size *Acrothele matthewi* is allied to *A. coriacea* Linnarsson. The interiors of the valves are also much alike, as may be seen by comparing Plate LVI, figures 1a–c, with Plate LXI, figures 1c and 1d (ventral valves), and Plate LVI, figure 1e, with Plate LXI, figure 1g (dorsal valves). The main vascular sinuses of the ventral valve of *A. matthewi* are stronger than those of *A. coriacea*, and the outer, granular surface of the epidermal layer is also much coarser. *Acrothele matthewi* differs from *Acrothele* (*Redlichella*) *granulata* (Linnarsson) in its smaller size and in the markings on the interior of the ventral valve; the granulated outer surface of the two species is similar, the differences between them not being greater than the variations on different portions of the same shell. From *A. avia* Matthew and *A. proles* Matthew this species is separated by the surface characters. It is difficult to institute detailed comparisons of outline and form of *A. matthewi* and other species, as both it and its varieties are represented by compressed and more or less distorted shells.

Acrothele matthewi is a variable species, and Matthew has proposed subspecific names for the most marked of the varieties. One variety (*A. matthewi eryx*) is recognized and named from China. A large form in Matthew's collection labeled "*Acrothele* cf. *granulata*" appears

to comprise large shells of *A. matthewi*. In the larger shells the granules become coarser toward the outer margins and are more irregularly distributed over the surface.

Of the varieties named by Matthew, "*A. matthewi prima*" appears to be of specific value on account of the position of the apex of the ventral valve. "*Acrothele matthewi costata*" is a variety of *A. prima*, and *A. matthewi multicostata* and *A. matthewi lata* appear to be the only varieties remaining that are sufficiently persistent and definite to be recognized, and even these merge by many gradations into the typical forms of the species.

The specific name was given in honor of Dr. G. F. Matthew.

FORMATION AND LOCALITY.—**Upper Cambrian**: (3) Shaly limestones 300 feet (91.4 m.) above the *Paradoxides* zone, Manuels Brook, Conception Bay, Newfoundland.

Middle Cambrian: (1a, 6n, and 61) Shales near the top of No. 6; (1) shales of zone A of No. 7; and (2) shales of zone B of No. 7; all in the Manuels Brook section [Walcott, 1891h, p. 261] on Manuels Brook, Conception Bay, Newfoundland.

(6g) Limestone near the base of the Middle Cambrian, the lowest horizon carrying *Paradoxides*, northwest side of Chapple Arm Harbor, about 1 mile (1.6 km.) from its head, Trinity Bay, Newfoundland.

(21 and 2m) Limestones and shales at the base of the *Paradoxides* zone [Matthew, 1895a, p. 108] on Hanford Brook; (**301h** [Matthew, 1886, p. 41]) shales of Division 1c of Matthew, on Hanford Brook; (**301i**) beds of Division 1b1 of Matthew, on Hanford Brook; (**301l** [Matthew, 1886, p. 41]) shales of Division 1d of Matthew, on Porters Brook, St. Martins; (**301g** [Matthew, 1886, p. 41])[a] sandstones of Division 1c of Matthew, at Portland (now part of the city of St. John); (2s) limestone in upper part of *Paradoxides* zone, at Hastings Cove [see Matthew, 1898b, p. 38], on Kennebecasis Bay, 0.5 mile (0.8 km.) northeast of Torryburn, on the Intercolonial Railway, northeast of St. John; (**3b**) shale at the base of the *Paradoxides* zone, at the head of Seeley Street, St. John; (**301k** [*Walcott, 1884a, p.16*]) *shales of the St. John formation at St. John;* and (**301j** [Walcott, 1884a, p. 16]) shales of the St. John formation at Ratcliffs Millstream; all in St. John County, New Brunswick.

ACROTHELE MATTHEWI ERYX Walcott.

Plate LXI, figure 2.

Acrothele matthewi eryx WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 29, p. 11. (Described and discussed as below as a new variety.)

In form, convexity, and size the ventral valve of the only specimen representing this variety is very similar to the typical forms of *Acrothele matthewi* (Hartt). The shell is partly exfoliated and shows a small oval pit about the pedicle opening and two narrow vascular sinuses that extend from a point nearly back of the pit about the pedicle opening, forward, and a little outward, about one-third the length of the valve.

The shell is built up of several layers or lamellæ that are smooth and shiny on the interior, except where slightly roughened by faint vascular markings and obscure radiating striæ; the outer surface is dull and marked by concentric striæ and lines of growth, and numerous fine, irregular, often anastomosing, elevated lines that give the surface a rough appearance.

The ventral valve is nearly circular, with a diameter of 6 mm. If this shell were associated with *Acrothele matthewi* in the Middle Cambrian rocks of New Brunswick, I should not hestitate to identify it with that species. In the absence of a series of specimens, and of representatives of the dorsal valve, it is not certain that it is identical with *Acrothele matthewi*.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**C4**) Limestone nodules at the base of the lower shale member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 40 (2d list of fossils), and fig. 10 (bed 4), p. 38], 3 miles (4.8 km.) southwest of Yenchuang, Sintai district, Shantung, China.

ACROTHELE MATTHEWI LATA Matthew.

Plate LXI, figure 3.

Acrothele matthewi lata MATTHEW, 1886, Trans. Roy. Soc. Canada for 1885, 1st ser., vol. 3, sec. 4, No. 4, p. 41, Pl. V, figs. 17 and 17a. (Described as a new variety. The specimen represented by figs. 17 and 17a is redrawn in this monograph, Pl. LXI, fig. 3.)

Acrothele matthewi lata Matthew, HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, Pl. III, figs. 25 and 26. (Fig. 26 is drawn from the specimen figured by Matthew, 1886, Pl. V, figs. 17 and 17a.)

[a] This species also occurs in Locality **308h**.

Acrothele matthewi lata Matthew, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, **Pl. III**, figs. 26–28. (No text reference. Figs. 27 and 28 are drawn from the specimen figured by Matthew, 1886, Pl. V, figs. **17** and 17a. Figs. 26 and 27 are copied from figs. 25 and **26**, respectively, of the preceding reference.)

Acrothele matthewi lata Matthew, 1895, Trans. New York Acad. Sci. for 1894–95, vol. 14, Pl. V, figs. 8a–b. (No text reference. Figs. 8a–b are copied from Matthew, 1886, Pl. V, figs. 17 and 17a, respectively.)

Acrothele matthewi lata Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 104, Pl. V, figs. 6a–b. (Mentioned. Figs. 6a–b are copied from Matthew, 1902a, Pl. XVII, figs. 6a–b, respectively.)

This variety is characterized by having a flatter rim that gives the valves a depressed appearance around the border. There are many variations that tend to unite it with typical examples of the species, but there is no difficulty in recognizing the typical forms of the variety.

Formation and locality.—**Middle Cambrian**: (**301** [Matthew, 1886, p. 42]) Sandstones of Division 1b2 of Matthew, on Hanford Brook; (**301a** [*Matthew, 1895a, Pl. V, fig. 8*]) *fine-grained sandstones below the Protolenus-bearing shales and sandstones in Division 1b3 of Matthew, on Hanford Brook;* and (**301g** [Matthew, 1886, p. 41]) sandstones of Division 1c of Matthew, at Portland (now a part of the city of St. John); all in St. John County, New Brunswick.

Acrothele matthewi multicostata Matthew.

Plate LXI, figures 5, 5a–c.

Acrothele matthewi multicostata Matthew, 1897, Trans. Roy. Soc. Canada for 1897, 2d ser., vol. 3, sec. 4, No. 7, p. 168. (Characterized as a new variety.)

This variety is distinguished from the typical forms of the species by the presence of numerous narrow, more or less obscure, radiating ribs. There is a gradation in this respect to typical forms of *A. matthewi*, where an occasional trace of ribs occur. The more anterior position of the apex of the ventral valve serves to distinguish this variety from *A. prima costata*, which occurs at a slightly lower horizon at the same locality.

This form owes its varietal name to the numerous radiating ribs upon its shell surface.

Formation and locality.—**Middle Cambrian**: (**2s** and **2t**) [a] *Shales* and interbedded limestone *in the upper part of the Paradoxides zone, Hastings Cove* [*Matthew, 1898b, p. 38*], *on Kennebecasis Bay, 0.5 mile (0.8 km.) northeast of Torryburn, on the Intercolonial Railway, northeast of St. John;* and (**21**) limestone at the base of the *Paradoxides* zone [Matthew, 1895a, p. 108], on Hanford Brook; both in St. John County, New Brunswick.

Acrothele? minuta Walcott.

Plate LXIII, figure 3.

Acrothele? minuta Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 303. (Described as below as a new species.)

Shell minute, 1.5 mm. in diameter, subcircular in outline, gently convex, with a slight median depression from the umbo to the anterior margin; back of the umbo there is a sharp median depression between minute ridges on each of which there are two points or nipples. Surface marked by fine concentric striæ. Substance of shell apparently phosphatic.

This interesting little species is represented by a single specimen. The generic reference is somewhat doubtful.

Formation and locality.—**Middle Cambrian**: (**C6**) Thin slabby limestone in the upper shale member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 41 (2d list of fossils), and fig. 10 (bed 12), p. 38], 2.5 miles (4 km.) southwest of Yenchuang, Sintai district, Shantung, China.

Acrothele nitida (Ford).

Plate LVIII, figures 4, 4a.

Obolella nitida Ford, 1873, Am. Jour. Sci., 3d ser., vol. 5, p. 213. (Described as on p. 651 as a new species.)

Obolella nitida Ford, Walcott, 1886, Bull. U. S. Geol. Survey No. 30, pp. 118–119, Pl. XI, fig. 2. (Original description copied. The specimen represented by fig. 2 is redrawn in this monograph, Pl. LVIII, fig. 4.)

Obolella nitida Ford, Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 612, Pl. LXXII, fig. 1. (New localities mentioned. Figure copied from preceding reference.)

Obolella nitida Ford, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 70. (Mentioned.)

[a] 2t is the type locality, though the specimens in the United States National Museum collections to which that number is assigned were collected later than Matthew's type specimens.

Linnarssonia? nitida (Ford), Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 673. (Merely changes generic reference.)
Obolella nitida Ford, Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 189, fig. 223c. (Described. Fig. 223c is copied from Walcott, 1886, Pl. XI, fig. 2.)

The original description by Ford follows:

Shell transversely suboval, small. Dorsal valve gently but irregularly convex, the greatest elevation occurring at a point about one-fifth the length of the valve from the apex. From this point the beak curves sharply down to the hinge line, which it almost touches. The hinge line itself is slightly curved and apparently equal to about one-third the width of the shell. At the most elevated point of the valve commences a well-defined median depression, which extends forward for a distance of about one-half the length of the valve, gradually widening and becoming more shallow until it disappears. A portion of the dorsal valve close to the margin is sometimes nearly flat all around. The internal markings are not well enough shown in any of the specimens that I have seen to admit of description. The surface is ornamented with very fine concentric striæ and numerous close set radiating striæ, the whole just visible to the unassisted eye.

The ventral valve is not certainly known. The width of the largest dorsal valve that I have seen is 0.14 of an inch and the length 0.1 of an inch.

Through the courtesy of Prof. J. M. Clarke I have had the opportunity of studying the type material of this species, now in the New York State Museum collections. There are four specimens of the dorsal valve and one representing the ventral valve. The reference to *Obolella* [Ford, 1873, p. 213] and *Linnarssonia* [Walcott, 1901, p. 673] is incorrect. The shell is like that of *Acrothele* and the matrix representing the ventral valve shows all the characters of *Acrothele* as far as any characters are shown at all. The slope of the valve toward an eccentric apex is indicated in the same manner as in *Acrothele matthewi* (Hartt).

The only difference detected between this shell and young shells of *Botsfordia cælata* (Hall) is the absence of the characteristic pustulose surface of the latter. Five of Mr. Ford's specimens appear to have come from the same piece of limestone, and nothing that can be identified as the same species has been found in the large collection made at the same locality.

The largest shell has a diameter of 3 mm. The surface is marked by fine concentric striæ, and sharp, interrupted, radiating lines.

Formation and locality.—**Lower Cambrian**: (27) *Even-bedded and conglomerate limestones on the ridge in the eastern suburb of Troy, Rensselaer County;* and (22) limestone 1.5 miles (2.4 km.) north of North Granville, Fort Ann quadrangle (U. S. Geol. Survey), Washington County; both in New York.

Acrothele panderi n. sp.

Plate LIX, figures 5, 5a–c.

This species is of the same general type as *Acrothele colleni* n. sp. It differs in having a less elevated and more posterior apex on the ventral valve, and the finer granulation of the exterior of the shell; also in the presence of a median depression or sinus on the dorsal valve.

The surface is more like that of *Acrothele* (*Redlichella*) *granulata* (Linnarsson) as the granulation, although of the same type as that on *A. coriacea* Linnarsson and *A. colleni*, has more the appearance of an epidermal granulated layer.

The description of *A. colleni* applies to this shell with the exceptions mentioned, and a few other details. It also reaches a somewhat larger size. One specimen of the ventral valve has a transverse diameter of 11 mm., with a length of 9 mm. Another example of the same valve has an equal length and breadth; usually the dorsal valve is a little broader than long, and it is marked by a clearly defined median depression that extends from the beak forward, gradually widening to the front margin. The apex of the ventral valve has a minute tubercle on each side, with a small pedicle opening on the slope just back of the tubercles, in this respect closely resembling the apex of *A. coriacea*.

The interior of the ventral valve shows a thickening of the shell under the short visceral area in front of the pedicle opening; the main vascular sinuses appear to originate beside or a little in advance of the pedicle opening and extend forward, gradually separating, but occupying a position about halfway between the margins and the median line.

The specific name is given in honor of Dr. C. H. Pander.

FORMATION AND LOCALITY.—**Lower Cambrian**: (**4v**) *About 200 feet (61 m.) above the unconformable base of the Cambrian and 75 feet (22.9 m.) above the top of the quartzitic sandstones in a shale which corresponds in stratigraphic position to shale No. 6 of the Dearborn River section* [*Walcott, 1908f, p. 202*], *Gordon Creek, 6 miles (9.6 km.) from South Fork of Flathead River, Ovando quadrangle (U. S. Geol. Survey);* and (**5j**) the same stratigraphic horizon as 4v, about 6 miles (9.6 km.) west-northwest of Scapegoat Mountain, on the Continental Divide between Bar Creek and the headwaters of the south fork of North Fork of Sun River, Coopers Lake quadrangle (U. S. Geol. Survey); both in Powell County, Montana.

ACROTHELE PRETIOSA (Billings).

Plate LVIII, figures 1, 1a–g.

Obolella pretiosa BILLINGS, 1862, Geol. Survey Canada, Paleozoic Fossils, vol. 1, pp. 68–69, figs. 61a–b. (Described and discussed as a new species.)

Obolella pretiosa BILLINGS, 1863, Geol. Survey Canada, Fifteenth Rept. Progress, p. 230, figs. 239a–b. (No text reference. Figures are copied from preceding reference.)

Obolella pretiosa Billings, CHAPMAN, 1863, Canadian Jour. Industry, Sci., and Art, new ser., vol. 8, p. 191, fig. 160b.

Obolella pretiosa Billings, CHAPMAN, 1864, Minerals and Geology of Canada, p. 163, fig. 160b. (Copy of preceding reference.)

Obolella? pretiosa Billings, WALCOTT, 1886, Bull. U. S. Geol. Survey No. 30, p. 111. (Generic relations mentioned.)

Billingsia pretiosa (Billings), FORD, 1886, Am. Jour. Sci., 3d ser., vol. 31, p. 467. (Merely changes generic reference.)

Elkania pretiosa (Billings), FORD, 1886, idem, vol. 32, p. 325. (Merely changes generic reference.)

Not *Obolella* (*Linnarssonia*) *pretiosa* DAWSON, 1890, Trans. Roy. Soc. Canada for 1889, 1st ser., vol. 7, sec. 4, No. 3, pp. 53–54, figs. 26a–c. (Referred in this monograph to *Acrotreta sagittalis*.)

Not *Linnarssonia pretiosa* HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 70, Pl. III, figs. 43–44. (Referred in this monograph to *Acrotreta sagittalis*.)

Linnarssonia pretiosa SCHUCHERT (in part), 1897, Bull. U. S. Geol. Survey No. 87, p. 262. (Mere reference, but includes specimens referred to both *Acrotreta sagittalis* and *Acrothele pretiosa*.)

Acrothele pretiosa (Billings), WALCOTT, 1898, Proc. U. S. Nat. Mus., vol. 21, p. 402. (Merely changes generic reference.)

Linnarssonia pretiosa (Billings), WALCOTT, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 673. (Merely changes generic reference.)

?Linnarssonia pretiosa GRABAU and SHIMER, 1907, North American Index Fossils, vol. 1, p. 200. (Described, but not figured, and it is impossible to tell whether the authors are discussing the *Linnarssonia pretiosa* that is now referred to *Acrotreta sagittalis* or the true *Acrothele pretiosa*.)

General form transversely oval; convexity unknown, as all specimens are more or less flattened in the shale. Ventral valve with the apex near the posterior margin; pedicle aperture small, and at the apex, but whether on its posterior slope or summit can not be determined. Dorsal valve with the beak marginal, and greatest elevation on the umbo on the posterior third of the valve.

Surface marked by numerous concentric lines and striæ of growth and a varying number of irregular, low, narrow, more or less interrupted, radiating ribs; in addition there is a minutely roughened surface formed by very fine, irregular, elevated lines that have minute granules upon them; this results in a surface much like that of *Acrothele matthewi* (Hartt).

The average diameter of the larger specimens is 5 mm., though there are many less than 2 mm. across.

The cast of the interior of a ventral valve shows the cast of a small oval apical callosity; the interior of the dorsal valve has a narrow median ridge that extends forward to the anterior fifth of the length of the valve; the main vascular sinuses are narrow and have the usual direction from the median line near the posterior margin outward and then obliquely forward. The only muscle scars observed are the cardinal scars on each side of the median ridge between the main vascular sinuses and the posterior margin, and the elongate oval central scars in advance of the transverse center of the valve.

Observations.—Owing to the compressed and more or less distorted condition of the specimens representing this species, it is difficult to give an accurate description of it. The posterior position of the apex of the ventral valve, concentrically striated surface, long median ridge in dorsal valve, and position of central scars, give the species an assemblage of detailed characters unknown in other species of the genus.

FORMATION AND LOCALITY.—**Ordovician**: (**220a**) *Shales of the "Upper Sillery" (Lauzon of Logan), on Chaudiere River at the Grand Trunk railroad bridge;* and (**319c** [Billings, 1862b, p. 69]) shales at Cape Rouge, above Quebec; both in the Province of Quebec, Canada.

(43) Shales on the summit of Moses Hill, 2 miles (3.2 km.) west of North Greenwich; and (338i) shales 1 mile (1.6 km.) west-northwest of South Argyle; both near the line between the Schuylerville and Cambridge quadrangles (U. S. Geol. Survey), Washington County, New York.

(338z) Limestone on the north side of Bald Mountain, about 2 miles (3.2 km.) northwest of Greenwich, Schuylerville quadrangle (U. S. Geol. Survey), Washington County, New York.

Acrothele prima (Matthew).

Plate LXI, figures 6, 6a–b; Plate LXII, figure 2.

Acrothele matthewi prima Matthew, 1886, Trans. Roy. Soc. Canada for 1885, 1st ser., vol. 3, sec. 4, No. 4, p. 41, Pl. V, figs. 16 and 16a. (Characterized. The specimen represented by figs. 16 and 16a is redrawn in this monograph, Pl. LXI, fig. 6.)

Acrothele matthewi prima Matthew, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, Pl. III, fig. 27. (Fig. 27 is drawn from the specimen represented in Matthew, 1886, Pl. V, figs. 16 and 16a.)

Acrothele matthewi prima Matthew, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, Pl. III, fig. 25. (No text reference. Fig. 25 is copied from fig. 27 of the preceding reference.)

Acrothele matthewi prima Matthew, 1895, Trans. New York Acad. Sci. for 1894–95, vol. 14, Pl. V, figs. 7a–b. (No text reference. The figures are drawn from the specimen represented in Matthew, 1886, Pl. V, figs. 16 and 16a.)

Acrothele matthewi prima Matthew, 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 5, No. 20, pp. 397 and 402, Pl. XVII, figs. 4a–b. (Mentioned. The figures are copied from figs. 7a–b, respectively, of the preceding reference.)

Acrothele matthewi prima Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 104, Pl. V, figs. 4a–b. (Mentioned. Figs. 4a–b are copied from Matthew, 1902a, Pl. XVII, figs. 4a–b, respectively.)

Acrothele matthewi Grabau and Shimer (in part), 1907, North American Index Fossils, vol. 1, p. 200, fig. 234g (not 234f). (Described. Fig. 234g is copied from Matthew's figure, 1895a, Pl. V, figs. 7a–b, of *Acrothele matthewi prima*. The specimen represented by fig. 234f belongs with *Acrothele matthewi*, which see, p. 648.)

This species is distinguished from *Acrothele matthewi* (Hartt) by the apex of the ventral valve being almost directly over the posterior margin instead of from one-fifth to one-sixth the length of the valve from it. It has a finely granulated surface of the same type as that of *A. matthewi* and the valves are similar in outline except near the apex of the ventral valve. The average size of this species is a little less than that of *A. matthewi*.

The variety *costata* was separated by Matthew [1895a, p. 128] on account of the presence of six or more ribs; this character is an exceedingly variable one and of little value, as the ribs vary from a faint trace to twenty or more ribs, but as it has been used the varietal name is retained.

Formation and locality.—**Middle Cambrian**: (2g)[a] *Sandstones of Division 1b1;* (2f) sandstones 3 feet below 2g in Division 1b1; (2h) sandstones of Division 1b2; and (2i) sandstones of Division 1b3; all in Matthew's [1895a, p. 108] *Protolenus* zone, Hanford Brook, St. John County, New Brunswick.

(13t) Sandstones at the base of Division E1b; and (13d″) sandstones 10 feet (3 m.) below Division E2a; both in Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

Acrothele prima costata (Matthew).

Plate LXI, figures 4, 4a–d.

Acrothele matthewi costata Matthew, 1895, Trans. New York Acad. Sci. for 1894–5, vol. 14, p. 128, Pl. V, fig. 9. (Characterized as a new variety.)

Acrothele matthewi costata Matthew, 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 5, No. 20, p. 397, Pl. XVI, fig. 6. (Mentioned. Fig. 6 is copied from fig. 9 of the preceding reference.)

Acrothele matthewi costata Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 104, Pl. IV, fig. 6. (Mentioned. Fig. 6 is copied from Matthew, 1902a, Pl. XVI, fig. 6.)

Matthew [1895a, p. 128] separated this variety on account of the presence of six or more broad, radiating ribs that are not continuous, but that are interrupted by some of the strong lines of growth; the ribs do not occur on very young shells or near the umbo of the old shells. The surface of the epidermal layer is granulated in the same manner as the typical forms of *A. matthewi* (Hartt).

[a] **2g** is the type locality, though the specimens in the United States National Museum collections to which that number is assigned were collected later than the type specimens.

The variation in the strength and number of ribs is from a slight trace of one or two short ribs near the front margin to twenty or more ribs. One extreme is represented (Pl. LXI) by figure 4a, and the other by figure 4. The specimens illustrated are from the same layer of rock. *A. matthewi multicostata* Matthew is similar to *A. prima costata* in surface characters and the presence of radiating ribs, but it differs in the more anterior position of the apex on the ventral valve.

The variety *costata* occurs in association with *A. prima* and is distinguished from it by the presence of more or less distinctly indicated ribs.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**2h**) *Sandstones of Division 1b2;*[a] (**301d** [Matthew, 1895a, p. 128]) sandstones of Division 1b5;[a] (**2i**) sandstones of Division 1b3; and (**2k**) just above 2i, in the sandstones of Division 1b3; all in Matthew's [1895a, p. 108] *Protolenus* zone, Hanford Brook, St. John County, New Brunswick.

(**301l** [Matthew, 1895a, p. 128]) Sandstones of Division 1d at Porters Brook, St. John County; and (**301f** [Matthew, 1895a, p. 128]) sandstones of Division 1b5 of Matthew's *Protolenus* zone, at Catons Island, Long Reach, St. John River, Kings County; all in New Brunswick.

(**6n**) Shales near the top of No. 6 of the Manuels Brook section [Walcott, 1891b, p. 261], Manuels Brook, Conception Bay, Newfoundland.

ACROTHELE PRIMÆVA (de Verneuil and Barrande).

Plate LVII, figure 6.

Discina (Orbicula) primæva DE VERNEUIL and BARRANDE, 1860, Bull. Soc. géol. France for 1859–60, 2d ser., vol. 17, p. 532, Pl. VIII, figs. 2 and 2a. (Described and discussed in French as a new species. Figs. 2 and 2a are reproduced in this monograph, Pl. LVII, figs. 6 and 6′, respectively.)

Acrothele primæva (de Verneuil and Barrande), POMPECKJ, 1896, Jahrb. K.-k. geol. Reichsanstalt for 1895, Bd. 45, Hft. 3, p. 603. (Discussed in German.)

This species appears to have been represented by only the ventral valve; this, the authors state, is corneous, slightly convex, and ornamented by very fine concentric striæ, and three fine lines that radiate from the apex to the front margin. On the figure the apex is about one-third the distance from the posterior to the anterior margin, and a faint false area is indicated by lines that diverge from the apex to the posterior margin.

As far as can be determined from the illustrations and descriptions of the two species, this form is most nearly related to *Acrothele quadrilineata* Pompeckj.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**350** [de Verneuil and Barrande, 1860, p. 538]) Red limestone of the *Paradoxides* zone, near Adrados, north of Sabero and Boñar, Cantabrian Mountains, Province of Leon, northwestern Spain.

ACROTHELE PROLES Matthew.

Plate LXII, figures 3, 3a–e, 4, 4a.

Acrothele proles MATTHEW, 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 5, No. 20, pp. 400–401, Pl. XVII, figs. 3a–e. (Described and discussed as a new species. The specimen represented by fig. 3a is redrawn in this monograph, Pl. LXII, fig. 4. Fig. 4a is drawn from one of Matthew's (unfigured?) specimens.)

Acrothele proles MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 60. (Notes on orientation.)

Acrothele proles MATTHEW, 1903, idem, pp. 102–103, Pl. V, figs. 3a–e. (Description and figures copied from Matthew, 1902a, pp. 400–401, Pl. XVII, figs. 3a–e.)

The most essential difference between this species and *Acrothele avia* Matthew is in the position of the apex of the ventral valve. There are certain minor differences in the visceral callosity, but these are variable and depend more or less upon the state of preservation of the shell. Nearly all the shells of *Acrothele* from the shales and arenaceous beds of the Nova Scotia localities have been distorted by flattening or lateral movement; on this account when one has but a few specimens it is difficult to place confidence on characters subject to change by very slight distortion of the shell.

[a] On the description of Plate V [Matthew, 1895a] Matthew says that the type specimen is from divisions 1b2 and 1b5; there is but one type specimen and it can not be ascertained to which of the two divisions it should be assigned. The specimens in the United States National Museum collections from Locality **2h** were collected later than the time at which Matthew made his collections.

Acrothele proles has the same type of surface as *A. avia*, also a strong shell that is often thickened in the vicinity of the apex; the number and strength of the radiating ridges vary with the thickness of the shell and the manner in which it has been compressed laterally.

The position of the apex of the ventral valve varies a little, but on the average it is nearer the posterior margin than in *A. avia* and not so near as in *A. prima* (Matthew).

FORMATION AND LOCALITY.—**Middle Cambrian: (13m)**[a] *Sandstones of Division E3f in Matthew's [1903, p. 76] Etcheminian, on Gillis Brook, Indian River;* and (**13 l'**) shaly sandstones of Division E3a; and (**13n**) sandstones of Division E3f; both in Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River; all in eastern Cape Breton, Nova Scotia.

ACROTHELE QUADRILINEATA Pompeckj.

Plate LVII, figure 5.

Acrothele quadrilineata POMPECKJ, 1896, Jahrb. K.-k. geol. Reichsanstalt for 1895, Bd. 45, Hft. 3, p. 511, Pl. XIV, figs. 6a–c. (Described and discussed in German as a new species; see below for liberal translation. Figs. 6b and 6c are reproduced in this monograph, Pl. LVII, figs. 5 and 5′, respectively.)

The original description by Pompeckj follows:

Ventral valve subcircular in outline; length, 7 mm.; width, 7.8 mm.; posterior margin slightly transverse. Apex low and about 2 mm. from the posterior margin; details of apex unknown; false area narrow and indefinitely defined from the apex to the posterior margin. Four flat ridges radiate from the apex toward the front margin. Surface marked by strong, closely arranged, concentric lines that under the microscope show very indistinct granulations. Dorsal valve unknown.

Pompeckj states [1896b, p. 511] that the ventral valve of this species is more arched than that of *Acrothele coriacea* Linnarsson. It is evidently a form closely allied to the latter and also to *Acrothele bohemica* (Barrande), which occurs at the same stratigraphic horizon in the "*Paradoxides* green slate."

FORMATION AND LOCALITY.—**Middle Cambrian:** (**345d** [Pompeckj, 1896b, p. 511]) Shales of *Paradoxides* zone, Forester house of Slapy (Buchava quarry), Skrej, Bohemia.

ACROTHELE RARA Walcott.

Plate LXIII, figures 4, 4a.

Acrothele rarus WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 303–304. (Described and discussed as below as a new species.)

Of this shell only the interiors of the valves are known. Shells of average size are about 3.5 mm. in diameter. The outline of the valves is subcircular, the transverse diameter being slightly more than the length of the valve.

The interior of the ventral valve shows that the valve was moderately convex, with a perforated apex about half a millimeter from the posterior margin. A short, broad median ridge extends for a short distance in front of the foraminal opening, and short, narrow ridges extend obliquely forward from each side of the opening. What may be lateral muscle scars occur close to the posterolateral margins. In the dorsal valve a strong median ridge extends from the posterior margin to the center of the valve; this ridge is angular at the summit and broadest toward its anterior end. A vascular sinus starts on each side of the base of the median ridge and extends obliquely forward.

The dark interior surface of the valves is marked by concentric lines that give a somewhat laminated appearance to the surface. From the manner in which the shell adheres to the limestone matrix it is probable that its outer surface is roughened by raised lines, somewhat as on *Acrothele subsidua* (White).

The data for comparison of this species with described species from America and Europe are too limited to be of value. A comparison with *Acrothele* (*Redlichella*) *granulata* (Linnarsson), of the Salt Range, India, shows a strong similarity in the interiors of the valves, but I do not

[a] **13m** is the type locality, though the specimens in the United States National Museum collections to which that number is assigned were collected later than the type specimens.

think that it is probable that the two forms are specifically identical, as the interiors of the valves of several species of *Acrothele* appear very much alike.

FORMATION AND LOCALITY.—**Middle Cambrian**: (C57) Limestone nodules in the lower shale member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 40 (first list of fossils)], 3 miles (4.8 km.) south of Kaokiapu and about 4 miles (6.4 km.) north of Sintaihien, Sintai district; and (C23) upper part of thin-bedded gray oolitic limestone at the base of the Changhia formation [Blackwelder, 1907a, p. 32 (list of fossils), and fig. 6 (bed 20), p. 25], 50 feet below the base of the cliffs 1 mile (1.6 km.) east-southeast of Changhia; both in Shantung, China.

ACROTHELE SPURRI Walcott.

Plate LX, figures 3, 3a–c.

Acrothele subsidua WALCOTT (in part) [not WHITE], 1886, Bull. U. S. Geol. Survey No. 30, p. 109, Pl. IX, fig. 4 (not figs. 4a–c). (Locality mentioned in discussion of *A. subsidua*. The specimen represented by fig. 4 is redrawn in this monograph, Pl. LX, fig. 3. Figs. 4a–c belong with *Acrothele subsidua*.)

Acrothele subsidua WALCOTT (in part) [not WHITE], 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 608, Pl. LXX, fig. 1 (not figs. 1a–c). (Mentioned. Fig. 1 is copied from fig. 4 of preceding reference. Figs. 1a–c belong with *Acrothele subsidua*.)

Acrothele subsidua Walcott, MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 103. (Discussed as possible new species.)

Acrothele spurri WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 86–87, Pl. VIII, fig. 14. (Described and discussed as below as a new species. Fig. 14 is a revised drawing of the specimen represented by fig. 4 of the preceding reference. Fig. 14 is copied in this monograph, Pl. LX, figs. 3, 3a–b.)

General form transversely ovate. Ventral valve depressed with an elevated apex a little in front of the posterior margin; from the apex the surface slopes rapidly and then gradually to the front margin, and quite rapidly to the posterior margin; the posterior margin arches up from the plane of the sides of the valves about one-half the height of the apex and gives to the valve the appearance of being pushed up so as to throw the apex toward the front; a minute pedicle opening truncates the apex at its posterior side; a small, subtriangular, convex false area extends from just back of the apex to the posterior margin.

Surface of the epidermal layer marked by fine, concentric striæ of growth and a very minute granulation; the inner laminations of the shell are shiny and marked by numerous radiating striæ and a few concentric lines. Shell corneous and built up of numerous layers or lamellæ more or less oblique to the outer layer.

Dorsal valve and interior of valves unknown. The largest ventral valve has a length of 6 mm.; width, 7 mm.

Observations.—This very striking species is associated with *Acrotreta primæva* Walcott and *Olenellus gilberti* Meek, in the upper portion of the *Olenellus* zone of central Nevada. Some fragmentary specimens of this species were referred by me [1886b, p. 109] to *Acrothele subsidua* (White), but with better material and more thorough study, the Lower Cambrian specimens are referred to *A. spurri*. *A. spurri* differs from *A. subsidua* in the more posterior position of its apex, in its convex, distinctly marked false area; in its strongly arched posterior margin; and in its more finely granulated surface. The convex false area and arched posterior margin are features also seen in *A. woodworthi* of the Lower Cambrian (Pl. LX, fig. 6).

The specific name is given in honor of Mr. J. E. Spurr.

FORMATION AND LOCALITY.—**Lower Cambrian**: (31a) *Limestone and interbedded siliceous shales of the Pioche formation [Walcott, 1908a, p. 11], just above the quartzite on the east side of the anticline, near Pioche, Lincoln County, Nevada.*

Specimens that are somewhat doubtfully referred to *Acrothele spurri* Walcott occur at the following locality:

Lower Cambrian: (11) Shales of No. 3 of the Silver Peak group [Walcott, 1908f, p. 189], 2.5 miles (4 km.) south of Barrel Spring and 0.5 mile (0.8 km.) east of the road, in the extreme southeastern corner of the Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County, Nevada.

ACROTHELE SUBSIDUA (White).

Plate LX, figures 1, 1a–o, 8.

Acrotreta? subsidua WHITE, 1874, U. S. Geog. Surveys W. 100th Mer., Prelim. Rept. Invertebrate Fossils, p. 6. (Described as a new species.)

Acrotreta? subsidua WHITE, 1877, U. S. Geog. Surveys W. 100th Mer., vol. 4, pt. 1, pp. 34–36, Pl. I, figs. 3a–d. (Described essentially as in preceding reference and discussed. The specimens represented by figs. 3a and 3d are redrawn in this monograph, Pl. LX, figs. 1 and 1n, respectively.)

Acrothele subsidua WHITE, 1880, Proc. U. S. Nat. Mus., vol. 3, p. 47. (Merely changes generic reference.)

Acrothele subsidua (White), WALCOTT (in part), 1886, Bull. U. S. Geol. Survey No. 30, pp. 108–109, Pl. IX, figs. 4a–c (not fig. 4). (Original description copied, but the paragraph added on p. 109 includes reference to specimens now referred to *Acrothele spurri*. Figs. 4a–c are drawn from the specimens figured by White, 1877, Pl. I, figs. 3a–d. Fig. 4 is now referred to *Acrothele spurri*.)

Acrothele subsidua (White), WALCOTT (in part), 1891, Tenth Ann. Rept. U. S. Geol. Survey, pp. 608–609, Pl. LXX, figs. 1a–c (not fig. 1). (The text reference mentions this species together with specimens which are now referred to *Acrothele spurri*. Figs. 1a–c are copied from Walcott, 1886b, Pl. IX, figs. 4a–c, respectively. Fig. 1 is now referred to *Acrothele spurri*.)

Acrothele subsidua (White), BEECHER, 1891, Am. Jour. Sci., 3d ser., vol. 41, Pl. XVII, fig. 12. (No text reference.)

Acrothele subsidua (White), HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 100 and 103, Pl. III, figs. 30 and 31. (Mentioned.)

Acrothele subsidua (White), MATTHEW, 1902, Trans. Roy. Soc. Canada for 1902, 2d ser., vol. 8, sec. 4, No. 3, p. 110. (Specimens from new locality characterized.)

Acrothele subsidua (White), GRABAU and SHIMER, 1907, North American Index Fossils, vol. 1, p. 200, figs. 234d–e, p. 199. (Described. Figs. 234d–e are copied from Walcott, 1886b, Pl. IX, figs. 4a–b, respectively.)

General form subcircular to transversely broad oval in outline with the posterior margin broadly rounded to slightly transverse in the dorsal valve. Ventral valve slightly convex toward the apex, with the apex between the posterior one-fifth to one-third the distance from the front to the back margin. The apex when perfect is formed of two minute elongate tubercles with a narrow elongate depression between them; the size and form of the tubercles and depression between them varies; in some specimens the tubercles are united in front, and in others there is a third minute tubercle just back of the apical depression. A pedicle opening varying from a minute circular to a small elongate-ovate aperture, narrow in front, occurs at the posterior end of the apical depression; it may have its narrow end well between the elongate tubercles or back of them. A triangular false area is well defined on some shells, and very obscure on others; it is often divided midway by an elevated line which in some examples is a narrow rounded ridge extending from just back of the pedicle opening to the posterior margin; the concentric striæ of growth cross the area and its median ridge or line without interruption; casts of the interior show the outline of the false area more or less distinctly. The posterior margin is usually slightly arched beneath the false area.

The dorsal valve is depressed convex, with the greatest elevation in front of the posterior margin; the beak is minute, marginal, and divided at the center by an elongate depression that leaves a very minute, slightly elevated, elongate tubercle on each side.

The exterior surface is marked by concentric lines of growth that vary in prominence and strength, and some ventral valves have a few low, rounded, radiating costæ; the costæ differ greatly in length and size, and are entirely absent on many shells. The epidermal layer is ornamented with a minute granulation formed of very minute granules distributed more or less irregularly on irregular raised lines distinct from the concentric striæ of growth, or apparently at times superimposed on the latter. The shiny inner layers of the shell are marked by fine, radiating striæ and concentric lines and narrow radiating depressions corresponding to the external costæ. The shell is corneous and built up of thin layers or lamellæ that give it some thickness over the visceral portions; the inner lamellæ are slightly oblique to the outer surface. The average size of the shells at the typical locality at Antelope Springs is from 5 to 6 mm. in length by 6 to 7 mm. in width; a few miles distant and a little higher in the strata, shells occur 8 to 10 mm. in diameter. Near Montpelier, Idaho, shells from 13 mm. in diameter to young shells 3 mm. in diameter occur in the same bed of shale.

In the interior of the ventral valve a narrow main vascular sinus arches outward from each side a little back of the pedicle opening, and then forward into the anterior half of the valve. The pedicle opening is elongate oval in outline, and has a slightly elevated rim about it and on each side a depression corresponding to the elongate tubercles on the exterior of the shell;

the visceral cavity in front of the opening is short, and in some shells very minute pits along the front indicate muscle scars that are too imperfectly preserved to be identified.

In the posterior half of the interior of the dorsal valve there is a strong median ridge that bifurcates near the center; this ridge enlarges where the central muscle scars (h) occur on its outer slopes and contracts before bifurcating just in advance of the anterior lateral muscle scars (j) (Pl. LX, fig. 1 l). The main vascular sinuses originate near the posterior margin at the end of the median ridge and extend first outward and then obliquely forward as narrow, nearly straight sinuses that are most deeply impressed in the shell at the inner and outer margins. The muscle scars have left very faint impressions on the shell. The cardinal scars (cl) are small and situated at the sharp angle formed by the main vascular sinuses and the posterior margin of the shell (Pl. LX, fig. 1k). The size and position of the central scars (h) and anterior lateral scars are indicated on Plate LX, figure 1 l.

I have been able to discover no trace of a true area in either valve; the posterior margins of the valves show concentric striæ and often the under side is striated, the surface apparently not having been rubbed against the edge of the opposite valve.

Observations.—There are some noticeable variations in this species, one of which I have separated as the variety *lævis*. In addition there is a variation in the position of the apex of the ventral valve that is often very marked; part of this variation is explained by the compression and consequent distortion of the shells, but there is also a range in the distance of the apex from the posterior margin of about one-fifth to one-third the length of the valve.

Acrothele subsidua lævis is separated on account of the smoother surface of a large group of shells occurring in the Middle Cambrian limestone near Ophir, Utah.

The specimens from the Lower Cambrian of Pioche, Nevada, which I [1886b, p. 109] referred to *Acrothele subsidua* are now referred to *A. spurri*, as more perfect specimens show that although they have the same type of surface the apex of the ventral valve is nearer the posterior margin and the posterior margin is strongly arched below the false area.

A. subsidua is the Cordilleran representative of the Swedish *Acrothele coriacea* Linnarsson and the American Atlantic coast *A. matthewi* (Hartt). It differs from *A. coriacea* in its more finely granulated surface, in the average more anterior position of the apex, in the average more circular outline of the ventral valve, and in the main vascular sinuses and their branches in the ventral valve. From *A. matthewi* it differs in surface characters and interior vascular markings. *A. subsidua* is much like *Acrothele* (*Redlichella*) *granulata* (Linnarsson) in form and size, but it differs in not having the strong granulations of the latter species upon its outer surface, also in having different interior vascular markings.

The vertical range of this species in the House Range section is from the lower portion of the Wheeler formation up into the top of the Marjum limestone, a vertical distance of about 1,200 feet. In the shales of the Wheeler formation it is associated with *Asaphiscus wheeleri* Meek, *Ptychoparia kingi* (Meek), and *Agnostus interstrictus* White. In the Marjum limestone this fauna disappears and a new subfauna of the Middle Cambrian fauna appears in which *Obolus mcconnelli* (Walcott) and *Micromitra* (*Iphidella*) *pannula ophirensis* (Walcott) occur. At Ophir, in the Oquirrh Range, *Acrothele subsidua lævis* is abundant at about the same horizon as the lower portion of the Marjum limestone. On the west front of the Wasatch Range, in Utah, it is associated with *Obolus mcconnelli* (Walcott) and *Acrotreta ophirensis* Walcott.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**55t**) [a] About 350 feet (106.7 m.) above the Brigham quartzite, in the limestone of the Ute limestone [Walcott, 1908a, p. 7], on the west side of the road, 0.5 mile (0.8 km.) above the forks, Paradise Dry Canyon (locally known as East Fork), east of Paradise, Cache County, Utah.

(**32p** and **55e**) Spence shale member of the Ute limestone, about 100 feet (30.5 m.) above the Brigham quartzite [Walcott, 1908f, p. 197], at the mouth of the first small canyon south of Wasatch Canyon; and (**54q**) a drift block supposed to have come from about 1,700 feet (518.2 m.) above the Brigham quartzite, a horizon correlated with the shales forming 2d of the Bloomington formation in Blacksmith Fork Canyon [Walcott, 1908f, p. 195], in Wasatch Canyon; both east of Lakeview ranch, about 5 miles (8 km.) north of Brigham, Boxelder County, Utah.

[a] The species is somewhat doubtfully identified from this locality.

(**15b**) About 1,700 feet (518.2 m.) above the Lower Cambrian and 2,700 feet (823 m.) below the Upper Cambrian, in the shaly limestones and calcareous shales of the Wheeler formation [Walcott, 1908f, p. 181], near Swasey Spring; (**3s** and **8g**) same horizon as 15b, in the eastern part of Wheeler Amphitheater, east of Antelope Springs; (**11u**) lower portion of the shales forming the Wheeler formation in Rainbow Valley; (**4**) *drift pieces believed to have come from the horizon of 15b, collected near Antelope Springs;* (**3x**) about 2,200 feet (670.6 m.) above the Lower Cambrian and 2,200 feet (670.6 m.) below the Upper Cambrian in the limestones forming 1d of the Marjum limestone [Walcott, 1908f, p. 180], 2.5 miles (4 km.) east of Antelope Springs, in ridge east of Wheeler Amphitheater; (**11q**, **11y**, and **30g**) about 2,350 feet (716.3 m.) above the Lower Cambrian and 2,050 feet (624.8 m.) below the Upper Cambrian, in the limestone forming 1c of the Marjum limestone [Walcott, 1908f, p. 180], 2.5 miles (4 km.) east of Antelope Springs, in ridge east of Wheeler Amphitheater; and (**10y**) about 2,900 feet (884 m.) above the Lower Cambrian and 1,500 feet (457.2 m.) below the Upper Cambrian in the central part of 1a of the Marjum limestone [Walcott, 1908f, p. 179], about 1 mile (1.6 km.) south-southwest of Marjum Pass; all in the House Range [Walcott, 1908f, Pls. XIII and XV], Millard County, Utah.

(**5b** and **54s**) Dark blue-gray Langston limestone [Walcott, 1908f, p. 198], just above the Cambrian quartzitic sandstones, north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

(**55c** and **163**) Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], about 50 feet (15.2 m.) above the Brigham quartzite and 2,755 feet (839.7 m.) below the Upper Cambrian, in a ravine running up into Danish Flat from Mill Canyon; and (**59g**) limestones immediately overlying the Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], in a saddle north of the creek which flows into Mill Canyon from the west; both about 5 miles (8 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho.

(**58j**) About 1,900 feet (579 m.) above the Lower Cambrian, and 3,100 feet (945 m.) below the Upper Cambrian near the base of the limestone forming 2 of the Stephen formation [Walcott, 1908c, p. 238 (7)], on the east side of Mount Stephen, about 3,000 feet (914 m.) above the Canadian Pacific Railway track east of Field; and (**14s**) about 2,300 feet (701 m.) above the Lower Cambrian and 2,700 feet (823 m.) below the Upper Cambrian, in the *Ogygopsis* zone of the Stephen formation [Walcott, 1908f, p. 210], on the northwest slope of Mount Stephen, above Field on the Canadian Pacific Railway; both in British Columbia, Canada.

Acrothele subsidua hera Walcott.

Plate LX, figure 9.

Acrothele subsidua hera Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 87, Pl. VIII, fig. 15. (Described and discussed as below as a new species. Fig. 15 is copied in this monograph, Pl. LX, fig. 9.)

This variety is separated from *Acrothele subsidua* (White) by the more elongate outline of the ventral valve and more posterior position of the apex, the relative position of the latter being between the posterior position of the apex of *Acrothele spurri* and the more anterior position of the apex of *A. subsidua.* An obscurely defined false area begins at the apical opening and diverges toward the margin. It is marked by a slight median ridge. The exterior layers of the shell are exfoliated, carrying with them the outer portion of the apical opening. The inner portion is rather large, and from the presence of an elongate tubercle on each side it is apparent that there was a similar tubercle on the interior surface on each side of the apex a little in advance of the opening.

The surface of an interior layer is marked by fine concentric lines, numerous very fine radiating lines, and four sharp ridges that radiate from the apex to the front margin.

Observations.—This species is represented by a single specimen that occurs in the buff-weathering gray limestone interbedded in the shale carrying fragments of *Olenellus.* It is quite distinct from *A. spurri,* with which it is associated, and appears to be a progenitor of *A. subsidua,* which occurs so abundantly in the Middle Cambrian strata much higher up in the section.

Formation and locality.—**Lower Cambrian:** (**31a**) Limestone and interbedded siliceous shales of the Pioche formation [Walcott, 1908a, p. 11], just above the quartzite on east side of anticline, near Pioche, Lincoln County, Nevada.

Acrothele subsidua lævis n. var.

This variety is distinguished by the partial or complete absence of the fine granulation on the epidermal layer characteristic of *Acrothele subsidua* (White). The shells of the variety have the same general outline and form as the species, and vary in size from 3 to 7 mm. in diameter.

I do not regard this variety as having much value, as there are numerous gradations from the smooth surface to the granulated surface typical of the species.

The associated fossils indicate the central portion of the Middle Cambrian section at about the horizon of the lower portion of the Marjum limestone of the House Range section of Utah.

FORMATION AND LOCALITY.—**Middle Cambrian**: (3e) *Thin-bedded limestone less than 400 feet (121.9 m.) above the quartzitic sandstones of the Cambrian, at Ophir, Oquirrh Range, Tooele County;* and (3x) about 2,200 feet (670.6 m.) above the Lower Cambrian and 2,200 feet (670.6 m.) below the Upper Cambrian, in the limestones forming 1d of the Marjum limestone [Walcott, 1908f, p. 180], 2.5 miles (4 km.) east of Antelope Springs, in ridge east of Wheeler Amphitheater, House Range [Walcott, 1908f, Pls. XIII and XV], Millard County; both in Utah.

ACROTHELE TURNERI Walcott.

Plate LX, figures 7, 7a.

Acrothele turneri WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 87–88, Pl. IX, fig. 12. (Described and discussed as below as a new species. Fig. 12 is copied in this monograph, Pl. LX, fig. 7.)

General outline broad oval, ventral valve slightly conical, with the apex at about the posterior third of the length of the valve; apex short and perforated on the back side of its point by a minute pedicle opening; false area indicated by a slight flattening between the apex and posterior margin. Dorsal valve gently convex; beak marginal.

Surface marked by fine concentric lines and striæ of growth. Shell corneous and made up of a few very thin lamellæ.

The largest shell has a length of 2.5 mm.; width, 2.75 mm.

Observations.—This neat little shell differs from *Acrothele subsidua* (White) in the absence of the surface characters of that species and from *A. spurri* by the more anterior position of its beak and smooth surface. It belongs to the group of *Acrothele* represented by *A. borgholmensis*. (Compare Pl. LX, fig. 7, with Pl. LXIII, fig. 2.)

The specific name was given in honor of Mr. H. W. Turner.

FORMATION AND LOCALITY.—**Middle Cambrian**: (7r) *Calcareous shales 4 miles (6.4 km.) south-southeast of Emigrant Peak, Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County, Nevada.*

Specimens that are somewhat doubtfully referred to *Acrothele turneri* Walcott occur at the following locality:

Middle Cambrian: (54a) About 750 feet (228.6 m.) above the Brigham quartzite and 3,440 feet (1,048.5 m.) below the Upper Cambrian, in the shales forming 2a of the Ute limestone [Walcott, 1908f, p. 196], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

ACROTHELE VILLABOIMENSIS Delgado.

Acrothele villaboimensis DELGADO, 1904, Communicações Commissão Serviço Geol. Portugal, tome 5, fasc. 2, p. 365, Pl. IV, fig. 28. (Described and discussed in French as a new species.)

Obolella maculata DELGADO [not SALTER], 1904, idem, p. 364, Pl. IV, fig. 24. (Discussed in French.)

Delgado [1904, p. 365] states that this species is characterized by the longitudinally oval outline of the ventral valve. The photograph of the type specimen shows that the apex is a short distance from the posterior margin, and that distinct concentric lines of growth occur, also that there are three or more fine plications near the front margin. The presence of the plications appears to indicate that the specimen has been laterally compressed, and thus given a longitudinally oval outline. If this view is correct the outline of the ventral valve was probably nearly circular. It may be that Plate IV, figure 24, of "*Obolella maculata*" [Delgado, 1904, p. 364] represents the dorsal valve of this species.

The only form with which we can compare this species is *Acrothele maculata* (Salter) of the Middle Cambrian of Wales. Both species have the apex of the ventral valve far back toward the posterior margin. Distorted specimens of the ventral valve of *Acrothele maculata* have the same outline as the ventral valve of *A. villaboimensis*. It is not probable that they

are identical species; they are associated with quite different faunas and little is known of the specific details of either species.

This species derives its specific name from its occurrence near Villa Boim.

FORMATION AND LOCALITY.—**Lower Cambrian:** (**351** [Delgado, 1904, p. 365]) Shales at Monte de Valbom, northeast of Villa Boim, Province of Alemtejo, Portugal.

ACROTHELE WOODWORTHI Walcott.

Plate LX, figure 6.

Acrothele woodworthi WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 88, Pl. IX, fig. 11. (Described and discussed as below as a new species. Fig. 11 is copied in this monograph, Pl. LX, fig. 6.)

Ventral valve transversely and irregularly oval in outline, convex, with the apex a little back of the center of the valve; pedicle opening, as indicated by the matrix of the exterior, just back of the apex; a subtriangular, gently convex false area is obscurely outlined by lines radiating from the apex to the posterior margin; the posterior margin is arched upward one-third or more of the distance from the plane of the margin of the valve to the apex.

Surface marked by concentric growth lines with fine striæ between, and a number of low, rounded, more or less obscure, radiating ribs. The shell is relatively thick and replaced by the calcareous matter of the matrix.

Observations.—This species is based on two specimens of the ventral valve collected by Prof. J. B. Woodworth. The generic reference is not entirely satisfactory as the pedicle opening has not been clearly seen and the convex false area suggests the area of *Micromitra* (Pl. II, fig. 1) more than that of any *Acrothele* except *A. spurri* Walcott.

The specific name is given in honor of Prof. J. B. Woodworth.

FORMATION AND LOCALITY.—**Lower Cambrian:** (**326c**) "Nahant limestone," Pulpit rock, Nahant, Essex County, Massachusetts.

ACROTHELE YORKENSIS Walcott.

Plate LIX, figures 4, 4a–b.

Acrothele yorkensis WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 88–89, Pl. IX, fig. 10. (Described and discussed as below as a new species. Fig. 10 is copied in this monograph, Pl. LIX, fig. 4.)

This species is represented by the casts, in the fine clay shales, of the exteriors of the valves, and a few imperfect casts of the interior. The shell is large for a species of this genus. Ventral valve moderately convex, with the apex in a specimen 9 mm. long 1.5 mm. from the posterior margin. The general outline is subcircular, with the length and width approximately the same. Dorsal valve with the apex marginal. The original convexity of the valves is unknown, as all of the specimens are flattened in the shale.

Surface marked by concentric ridges and striæ of growth, and a few obscure, rounded, radiating ridges. In addition there is a fine granulation of the type of that of *A. coriacea*, the irregular, more or less inosculating, minute, rounded ridges having fine tubercles upon them.

A large ventral valve has a length and width of 11 mm. Other specimens of the same size occur, although the average size is about 8 mm. Substance of the shell is unknown.

One or two poor interiors of the ventral valve show a small visceral cavity, and rather slender main vascular sinuses that appear to originate beside the pedicle opening. The latter opens on the back slope of the apex and enlarges as it passes through the shell. The interior of the dorsal valve shows a rather strong central ridge that extends beyond the center of the shell, also a rather small cardinal scar on each side of the median ridge close to the posterior margin.

Observations.—This shell is of the general type of *Acrothele matthewi* (Hartt). It differs in its larger size, and it is not probable that a species would occur in the inner Appalachian trough which is present in the sediments near the margin of the Atlantic Basin. The fauna

associated with *A. yorkensis* is of the Middle Cambrian type of the interior trough and quite unlike that of the *Paradoxides* fauna of the Atlantic Coast Province. In size this species approaches *A. (Redlichella) granulata* (Linnarsson), but it differs from that species in its minutely granulated surface.

This species derives its specific name from its occurrence near York, Pennsylvania.

FORMATION AND LOCALITY.—**Middle Cambrian**: (48d) Argillaceous shales in railroad cut alongside of gas house, city of York, York County, Pennsylvania.

ACROTHELE sp. undt. a.

Plate LXIII, figure 5.

This species is represented by a single specimen of a cast of the interior. This cast shows the base of the apical opening, which is rather large, a short visceral cavity, the central portion of which was somewhat elevated, and clearly defined main vascular sinuses that originate at the sides of the base of the pedicle opening, and extend forward well toward the front of the valve, gradually diverging at the center, so as to be about one-third the distance from the median ridge to the margin; rather strong muscle scars occur beside the main vascular sinuses, where the latter curve forward into the body of the valve. Two scars, the transmedian and anterior lateral, are clearly shown. A fragment of the shell is preserved back of the cast of the pedicle opening that indicates that the shell was rather thick over the umbonal portions.

The specimen has a length of 7 mm., with the breadth the same. Nothing is known of the exterior surface. The interior shows a few obscure lines of growth and fine radiating striæ.

This species suggests the ventral valve of *Acrothele yorkensis* Walcott in form, but in the absence of an exterior or other characters for comparison, no specific designation is given to it.

FORMATION AND LOCALITY.—**Lower Cambrian**: (**319b**) Conglomeratic limestones containing *Olenellus?*, St. Simon, Province of Quebec, Canada.

ACROTHELE sp. undt. Moberg.

Acrothele MOBERG, 1892, Geol. Fören. i Stockholm Förhandl. for 1902, Bd. 14, Hft. 2, pp. 114–115, Pl. III, fig. 9. (Described in Swedish; see below for translation.)

Moberg describes the species as follows:

Of this genus, none but exfoliated specimens have been met with. They do not appear to show characters sufficient for specific determination. The shell has an almost circular circumference, with the back edge, along a distance constituting about one-fifth of the whole circumference, somewhat truncated. From the apex, which is situated near the posterior margin, the shell slopes pretty evenly both toward the anterior and the posterior margins, so that these two parts form approximately a right angle with each other at the apex. Traces of concentric lines of growth are visible.

In the position of the apex and the convexity of the ventral valve the cast of this shell is much like that of the forms from the Lower Cambrian of Bic, Canada (Pl. LXIII, fig. 5).

FORMATION AND LOCALITY.—**Lower Cambrian**: (**310e**) *Sandstone bowlder on the beach between Ekerum and Stora Rör;* (**310f**) sandstone bowlders west of Ekerum; and (**310g**) sandstone bowlders south of Stora Rör; all [Moberg, 1892b, p. 115] on Oeland Island, Sweden.

REDLICHELLA Walcott,[a] subgenus of ACROTHELE.

Acrothele (Redlichella) WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 89–90. (Described and discussed as below as a new subgenus.)

Acrothele (Redlichella) WALCOTT, 1908, idem, vol. 53, No. 4, pp. 142 and 146, and Pl. XI. (Classification of subgenus.)

This subgenus of *Acrothele* has all the external characters of the type species of *Acrothele, A. coriacea* Linnarsson. It differs in the interior markings of the valves. The visceral area

[a] The synonymy for this subgenus does not give a complete record of the various genera under which the species now included in *Redlichella* were formerly placed. It gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Acrothele Linnarsson [1876, p. 24].
Acrothele Swanston [1877, Pl. VII, figs. 20a–c].
Acrothele Linnarsson [1877, p. 373].
Acrothele Davidson [1883, p. 214].
Acrothele Walcott [1886b, p. 109].
Acrothele Swanston [1886, Pl. VII, figs. 20a–c].
Acrothele Hall and Clarke [1892c, p. 100].

of the ventral valve is large and clearly defined, as in *Botsfordia granulata* (Redlich), and the main vascular sinuses are very strong and close to the pedicle aperture, as in the latter species. In the interior of the dorsal valve the cardinal scars are very large and extend forward nearly one-third the length of the valve.

Type.—Acrothele granulata Linnarsson.

I was at first inclined to place this form under *Botsfordia,* but the advanced position of the apex and pedicle opening of the ventral valve indicates a closer affiliation with *Acrothele.* The short listrium of *Botsfordia* has developed in *Redlichella* to the strong false area of *Acrothele,* but the visceral area and main vascular sinuses of *Botsfordia* remain practically unchanged. I regard *Redlichella* as a form intermediate in development between *Botsfordia* and *Acrothele.*

The subgeneric name is given for Dr. Karl A. Redlich, of the Geological Survey of India.

Acrothele (Redlichella) granulata (Linnarsson).

Plate LVI, figures 2, 2a–n.

Acrothele granulata Linnarsson, 1876, Bihang till K. svensk. Vet.-Akad. Handl., Bd. 3, No. 12, p. 24, Pl. IV, figs. 51a–c (and 52?). (Described and discussed in English as a new species.)

Acrothele sp., *A. granulata* Linnarsson, Swanston, 1877, Proc. Belfast Naturalists' Field Club, Appendix 4, for 1876–77, Pl. VII, figs. 20a–c. (No text reference.)

Acrothele granulata Linnarsson, 1877, Geol. Föreu. i Stockholm Förhandl., No. 40, Bd. 3, No. 12, pp. 373–374, Pl. XV, figs. 12, 12a–b. (Described in Swedish.)

Acrothele granulata Linnarsson, Davidson, 1883, British Fossil Brachiopoda, vol. 5, pt. 2, p. 214, Pl. XVI, figs. 29, 29a, 30, 30a–b. (Original description copied and species discussed.)

Acrothele granulata Linnarsson, Walcott, 1886, Bull. U. S. Geol. Survey No. 30, p. 109. (Mentioned as closely related to *Acrothele subsidua.*)

Acrothele sp., *A. granulata* Linnarsson, Swanston, 1886, Systematic Lists, Flora, Fauna, Paleontology, and Archæology, North of Ireland, vol. I, Pl. VII, figs. 20a–c. (Reprint of Swanston, 1877, Pl. VII, figs. 20a–c.)

Acrothele granulata Linnarsson, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 100–101. (Discussed.)

The shell of *Acrothele* (*Redlichella*) *granulata* resembles so closely that of *Acrothele coriacea* Linnarsson (p. 642) that I will only call attention to the points of difference between them.

On the average, *A.* (*R.*) *granulata* is a longer, stronger shell; its surface is more coarsely granular, the pedicle aperture is much larger, and the tubercles in front of it much smaller. The false area is usually less distinct, but it is sometimes distinct and has a longitudinal median line; the posterior margin arches up at the false area, and the dorsal valve arches up so as to fit closely against the curved margin; the interior of the ventral valve of *A.* (*R.*) *granulata* has a visceral area that is obtusely pointed in front and on each side extends out to the main vascular sinuses, which originate nearer the pedicle opening than in *A. coriacea.* The main vascular sinuses of *A.* (*R.*) *granulata* are much nearer the median line than those of *A. coriacea.* The difference in the visceral area and vascular sinuses was found in specimens from the *Paradoxides forchhammeri* beds of Gudhem, and also the *P. œlandicus* zone of Bornholm.

In the dorsal valve of *A.* (*R.*) *granulata* the cardinal scars are longer and nearer the median ridge.

A large ventral valve has a length of 9 mm.; width, 10.5 mm. A large dorsal valve has a length of 10 mm.; width, 12 mm.

Acrothele (*Redlichella*) *granulata* is a form intermediate between the typical *Acrothele coriacea* Linnarsson and *Botsfordia granulata* (Redlich). It has the exterior appearance of *Acrothele coriacea,* and the apex of the ventral valve is well in advance of the posterior margin, but the interior of the ventral valve has the strongly marked visceral area of *Botsfordia granulata,* and strong vascular sinuses that are close to the pedicle opening.

Formation and locality.—**Middle Cambrian**: (**8z**) Limestones of *Paradoxides œlandicus* zone at Borgholm, Oeland Island; (**309f**) shale at Borgholm, Oeland Island; (**310o**) limestone of the *Paradoxides tessini* zone at Borgholm, Oeland Island; (**320s** [Linnarsson, 1877, p. 374]) at St. Frö, Oeland Island; (**320b**) limestones forming 2d of the *Paradoxides* zone, the *Agnostus lævigatus* horizon, at Gudhem, 12.5 miles (20.1 km.) south-southeast of Skara, Province of Skaraborg; (**320l** [*Linnarsson, 1876, p. 24*]) *drift blocks supposed to have come from the Paradoxides œlandicus zone* [*Linnarsson, 1876, p. 6*], *at Lillviken, near Oestersund, Province of Jemtland;* and (**320t** [Linnarsson, 1876, p. 24]) on Billstaån River, parish of Hackås, Province of Jemtland; all in Sweden.

Genus DISCINOLEPIS Waagen.

[δίσκος, quoit; and λεπίς, scale.]

Discinolepis Waagen, 1885, Mem. Geol. Survey India, Paleontologia Indica, 13th ser., Salt Range Fossils, vol. 1, pt. 4, fas. 5, pp. 749–750. (Described and discussed as a new genus, part of the next to the last paragraph being copied below.)

Discinolepis Waagen, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 247. (Described.)

Discinolepis Waagen, Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, p. 563. (Copy of preceding reference.)

Discinolepis Waagen, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 90. (Original description, Waagen, 1885, p. 749, copied.)

Discinolepis Waagen, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 146. (Classification of genus.)

As this genus is based on one species, the description of the latter will give all that is known of the genus. Waagen [1885, p. 749] states that this genus differs from all described genera of the Discinidæ:

> From *Discina*, *Discinisca*, and *Orbiculoides* it differs in having an incision and not a slitlike foramen in its lower valve for the passage of a peduncle. In *Trematis* a similar incision or emargination seems sometimes to occur, but the sculpture of the valves is quite different from that appearing in *Discinolepis*. *Schizocrania* has an incision, but it is much larger than in the Indian form.

Type.—*Discinolepis granulata* Waagen.

Discinolepis granulata Waagen.

Plate LXXXI, figures 3, 3a–b.

Discinolepis granulata Waagen, 1885, Mem. Geol. Survey India, Paleontologia Indica, 13th ser., Salt Range Fossils, vol. 1, pt. 4, fas. 5, pp. 750–751, Pl. LXXXVI, figs. 5, 6, and 7. (Described and discussed as a new species. The specimen represented by fig. 6 is redrawn in this monograph, Pl. LXXXI, fig. 3; the specimen represented by fig. 5 is redrawn (in different positions) in this monograph, Pl. LXXXI, figs. 3a and 3b.)

Discinolepis granulata Waagen, 1891, idem, vol. 4, pt. 2, Pl. II, figs. 15 and 16. (No text reference. Figs. 15 and 16 are drawn from the specimens represented in the preceding reference, Pl. LXXXVI, figs. 5 and 6, respectively.)

Discinolepis granulata Waagen, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 247, figs. 256 and 257. (No text reference. Figs. 256 and 257 are copied from Waagen, 1885, Pl. LXXXVI, figs. 5b and 7, respectively.)

Discinolepis granulata Waagen, Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, p. 563, figs. 256 and 257. (Copy of preceding reference.)

Discinolepis granulata Waagen, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 90, figs. 45 and 46. (No text reference. Figs. 45 and 46 are copied from Waagen, 1885, Pl. LXXXVI, figs. 5b and 7, respectively.)

Shell transversely broad oval. Ventral valve nearly flat except at the umbo and apex. Apex a little in front of the posterior margin and about three-fourths of a millimeter high; it is divided by a median depressed line which gives a slightly elevated semicircular node on each side. From the depressed median line a narrow, elongate, triangular opening extends to the margin of the valve; this opening has the position and form of the false deltidium of some species of *Acrotreta*, but there is no outline of an area. The lines and striæ of growth arch around and terminate at the edges of the opening.

Surface of the shell marked by fine concentric lines of growth and fine papillæ which are outlined by oblique lines curving from each side of the shell forward and then outward to the opposite side from which they originate. It is the same type of surface as that on *Micromitra* (*Iphidella*) *pannula* (White) (Pl. IV). Where the surface is slightly worn the papillæ appear like fine granules.

The substance of the shell appears to be calcareocorneous and the shell to be made up of several thin lamellæ. The two ventral valves are 5 mm. in width and 4 and 5 mm. in length, respectively.

These measurements differ from Waagen's, but as the shells are imperfectly preserved at margins the size assumed is a matter of personal judgment.

Waagen [1885, p. 750] describes the dorsal valve from specimens on a slab of sandy shale that are more or less crushed. The surface of these shells is marked only by very fine concentric striæ and two show an opening beneath the apex similar to that of the ventral valve of *Discinolepis granulata.* I do not find in the material any clearly defined dorsal valve with the papillose surface. The material representing the concentrically striated species is too poorly preserved to warrant the description of a second species. I do not know of any related species.

I am indebted to the director of the Geological Survey of India, Dr. T. H. Holland, for the opportunity to study and illustrate the type material of this genus and species.

FORMATION AND LOCALITY.—**Middle Cambrian**: Lower portion of the "*Neobolus* beds" of the Khussak group, in purplish-colored, fine-grained, micaceous sandstone at the following localities [Waagen, 1885, p. 751]; (357a) *at Jutána;* and (357c) near the fresh-water springs in the gorge above the salt mines at Kiura (Khewra); both in the Salt Range, India.

Subfamily ACROTRETINÆ Walcott and Schuchert.

Genus LINNARSSONELLA Walcott.[a]

Linnarssonella WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 601–602. (Described and discussed as below as a new genus.)

Linnarssonella WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 146. (Classification of genus.)

Ventral valve convex with a slightly incurved beak projecting over a low false area. Pedicle opening at the apex of the beak. A very slight trace of a pseudodeltidium occurs beneath the beak, dividing the false area midway, as in the genus *Micromitra;* the false area arches slightly upward and backward in some specimens, while in others of the same species its edge is nearly coincident with the plane of the edge of the shell. The true cardinal area is well defined and strongly marked by a shallow pedicle furrow (Pl. LXXVIII, figs. 8e and 9b). The dorsal valve is slightly convex, with a minute beak at the posterior margin. Surface marked by very fine concentric striæ and undulations of growth. Shell strong, thick, and built up of a thin outer layer and numerous inner layers or lamellæ that are arranged more or less obliquely to the outer layer. All the known species are small, not exceeding 2.5 mm. in diameter.

The cast of the interior of the ventral valve shows the presence of two well-marked cardinal scars, one on each side of the main vascular canals well toward the posterior border of the valves. The main vascular canals of the ventral valve were large, extending nearly to the frontal margin, and including between them back of the center of the valve a small visceral area. The cast of the pedicle opening occurs just in front of the union of the main vascular sinuses. The cast of the interior of the dorsal valve (Pl. LXXIX, fig. 11) shows two large cardinal scars; two central scars (h); and traces of a minute anterolateral scar (j); strong vascular canals; a well-defined area and pedicle furrow; and a narrow median ridge extending in some shells to the anterior third of the valve.

Type.—Linnarssonella girtyi Walcott; second species, *L. minuta* (Hall and Whitfield); third species, *L. tennesseensis* Walcott.

This is a most interesting type, combining characters of *Micromitra* and *Acrotreta. Bicia,* of the *Olenellus* fauna, has a strikingly similar dorsal valve, and the ventral valve is not unlike if the narrow pedicle furrow of *Bicia* is closed so as to provide a pedicle aperture.

Linnarssonella girtyi occurs in great abundance in a single layer in the Middle Cambrian of the Black Hills, North Dakota; also at two localities at the same relative stratigraphic horizon in Oklahoma and at several localities in the Middle Cambrian limestones of Missouri.

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[a] The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Linnarssonella* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Lingulepis? Hall and Whitfield [1877, p. 206].
Lingulepis? Walcott [1884b, p. 13].
Obolella? Walcott [1897a, p. 404].
Lingulella Schuchert [1897, p. 257].
Obolella Walcott [1899, p. 443].
Acrotreta Walcott [1901, p. 673].
Meekina Walcott [1905a, p. 313].

The Missouri specimens were at first thought to be a distinct species, to which the name *L. broadheadi* was given, but the description was not published. By oversight the name *L. broadheadi* was published [Walcott, 1902, p. 601] in the preliminary notes on the genus. The valves of *L. minuta* almost cover a fragment of sandy shale from the Eureka district, Nevada. *Linnarssonella tennesseensis* is fairly abundant in sandy shales and thin-bedded sandstones, also in argillaceous shales above the sandstone of the Rome formation. Three species occur in the Upper Cambrian of the House Range section of western Utah. The lowest in the section is *L. transversa;* about 200 feet higher in the section, *L. modesta;* and a short distance above, *L. nitens.* These species occur in abundance in the bluish-gray limestones. *Linnarssonella urania* is moderately abundant in the Middle Cambrian, compact, dove-colored limestones of the Wasatch Range.

Failing to establish a satisfactory genus in honor of Linnarsson in the first instance,[a] I make another attempt with this rare and interesting form.

Linnarssonella girtyi Walcott.

Plate LXXVIII, figures 5, 5a; Plate LXXIX, figures 1, 1a–r.

Linnarssonella broadheadi Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 601. (Name referred to but not defined or described.[b])

Linnarssonella girtyi Walcott, 1902, idem, pp. 602–603. (Described and discussed as below as a new species.)

Shell minute. General form broad ovate to subcircular. Ventral valve convex; beak small and slightly incurved over the false area; false area short and varying from vertical to a backward inclination of 45° to 50° with the plane of the edge of the valve; in some examples the margin of the false area arches (Pl. LXXIX, fig. 1a′) but in others it appears to be straight (fig. 1b). A very slightly indicated pseudodeltidium occurs beneath the beak that gradually widens to the margin, very much as in *Micromitra pealei.* Pedicle opening minute exteriorly, but the tube increases in size toward the inner surface of the shell. In one very perfect shell the aperture appears to open into a narrow elongate depression just in front of the beak, but it usually is seen as a minute, circular perforation at the apex of the beak. Dorsal valve gently convex, with a minute beak at the posterior margin. Surface of the shell glossy and smooth to the unaided eye, but a strong magnifier shows very fine concentric striæ and lines of growth; the inner surface is marked outside of the visceral area by very fine radiating striæ. The shell is formed of several layers or lamellæ, and, judging from the depth of the impressions of the muscle scars and vascular markings, rather thick over the central and posterior portions. The average length of the ventral valve is 1.5 to 1.75 mm.; the dorsal valve is slightly shorter.

The cast of the interior of the ventral valve shows the presence of a large cardinal scar on each side of the visceral area, and outside of the very strong vascular canal; they are oval in outline and probably the point of attachment of a strong muscle or muscles; their variation in size and position is shown by Plate LXXIX, figures 1k and 1m–p. The visceral area is small, but is well defined in Plate LXXIX, figures 1n, 1o, and 1p. Of the vascular canals only the main trunks are shown by strong ridges in the casts, their form and extension being finely exhibited by figures 1m to 1p; in figure 1k they extend almost in a direct line from the beak to the anterolateral margins of the valve. The cast of the interior of the pedicle tube is usually broken off; its position is shown in Plate LXXIX, figure 1n. The interior of the dorsal valve is beautifully shown by figure 1 l; the strong cardinal area with its well-defined pseudodeltidium, the large oval cardinal scars immediately in front of the area, and the strong vascular canals are as clearly defined as in the large shells of *Obolus.* The cardinal scars are divided into three parts by two transverse lines crossing the outer slope more or less obliquely, but the divisions on the two sides are unequal; the inner slopes of the scars are finely polished and afford no evidence of the attachment of muscles. Traces of the central scars occur on the outer slope

[a] *Linnarssonia* [Walcott, 1885, p. 115], now referred to *Acrotreta.*

[b] Under the impression that the forms were distinct this name was given to them, and the name was overlooked when the description of the genus was published [Walcott, 1902, p. 601].

of the cast of a rather strong median ridge; they are elongate oval in outline, the major axis inclining posteriorly toward the median ridge. What may be the impression of an antero-lateral scar occurs on the median ridge a little in advance of the central scars.

Observations.—Linnarssonella girtyi differs from *L. minuta* (Hall and Whitfield) in the greater convexity of the ventral valve and the median ridge of the dorsal valve. The Oklahoma specimens show a longer false area (Pl. LXXIX, fig. 1q″) on some shells but on others it is much like that of *L. girtyi* from the Black Hills.

The specific name is given in recognition of the paleontologic work of Dr. George H. Girty.

Formation and locality.—**Upper Cambrian**: (**369**) Sandstone in the Elvins formation in the eastern limits of the town of Flat River, St. Francois County, Missouri.

(**9q**) About 10 feet (3 m.) above the porphyry contact and 90 feet (27.4 m.) below the Arbuckle limestone, in limestone of the Reagan sandstone, in middle of W. ½ sec. 2, T. 4 N., R. 13 W.; (**9r**) about 45 feet (14 m.) above the porphyry contact in the limestone of the Reagan sandstone, in SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W.; and (**9p**) about 160 feet (48.8 m.) above the porphyry contact in the limestone of the Reagan sandstone, in SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W.; all about 15 miles (24.2 km.) northwest of Fort Sill, Comanche County, Oklahoma.

(**9v**) Limestone of the Reagan sandstone, about 250 feet (76 m.) below the Arbuckle limestone, SW. ¼ sec. 17, T. 4 N., R. 12 W., about 11 miles (17.7 km.) northwest of Fort Sill, Comanche County, Oklahoma.

(**12p**) About 225 feet (69 m.) above the igneous rocks in the limestone of the Reagan sandstone at the northwest extremity of the Arbuckle Mountains, about 4 miles (6.4 km.) east of Homer, Carter County, Oklahoma.

(**14i**) Limestone 1 mile (1.6 km.) west of Cherokee, San Saba County, Texas.

(**32t**) Limestone about 3,650 feet (1,112.5 m.) above the Cambrian quartzitic sandstones, in Fandango Spring canyon on the east side of the Dugway Range, about 5 miles (8 km.) north of where the stage road between Vernon and Deep Creek crosses the divide, Tooele County, Utah.

Middle Cambrian: (**88a**) *Limestone about 100 feet (30.5 m.) above the quartzitic sandstone at the base of the Cambrian, in the northern suburbs of Deadwood;* (**165**) limestone on the east side of the valley in railroad cut about 1 mile (1.6 km.) below the main part of Deadwood; and (**17k**) limestone thrown out on the dump of the Great Northern shaft, southeast of Twobit; all in the Black Hills, South Dakota.

(**11k**) Limestones of the "Edgewise beds," beneath the Elvins formation, St. Francois County; and (**11e**) thin-bedded limestone south-southwest of Potosi, Washington County; both in Missouri.

(**313e**) Limestone 2 miles (3.2 km.) west of Green's ranch, White Pine County, Nevada.

A shell that is somewhat doubtfully referred to this species occurs at the following locality:

Upper Cambrian: (**9q**) About 10 feet (3 m.) above the porphyry contact and 90 feet (27.4 m.) below the Arbuckle limestone, in limestone of the Reagan sandstone, in middle of W. ½ sec. 2, T. 4 N., R. 13 W., about 15 miles (24.2 km.) northwest of Fort Sill, Comanche County, Oklahoma.

Linnarssonella minuta (Hall and Whitfield).

Plate LXXIX, figures 2, 2a–b.

Lingulepis? minuta Hall and Whitfield, 1877, U. S. Geol. Expl. 40th Par., vol. 4, pt. 2, pp. 206–207, Pl. I, figs. 3 and 4. (Described and discussed as a new species. The specimens represented by Pl. LXXIX, figs. 2, 2a–b, occur on the same hand specimen of sandy shale as the specimens figured by Hall and Whitfield, but they are not the same specimens.)

Lingulepis? minuta Hall and Whitfield, Walcott (in part), 1884, Mon. U. S. Geol. Survey, vol. 8, p. 13. (Localities and range mentioned, see p. 668.)

Obolella? minuta (Hall and Whitfield), Walcott, 1897, Am. Jour. Sci., 4th ser., vol. 3, p. 404. (Merely changes generic reference.)

Lingulella minuta (Hall and Whitfield), Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 257. (Merely changes generic reference.)

Obolella minuta (Hall and Whitfield), Walcott, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, p. 443. (Merely changes generic reference.)

Acrotreta minuta (Hall and Whitfield), Walcott, 1901, Proc. U. S. Nat. Mus., vol. 23, p. 673. (Merely changes generic reference.)

Linnarssonella minuta (Hall and Whitfield), Walcott, 1902, idem, vol. 25, pp. 603–604. (Described and discussed as below.)

Shell small; general form broad ovate, with the ventral valve slightly subacuminate. The convexity of the two valves is nearly the same and in each the minute beak appears to be at the posterior margin. The false area of the ventral valve is small and divided midway by a faint, narrow pseudodeltidium; it is on the plane of the margin of the valve. Pedicle

opening minute, elongate, and situated on the slope just in front of the beak. Dorsal valve a trifle less convex than the ventral.

The outer surface of the shell is marked by fine concentric striæ and lines of growth, and the inner lamellæ and inner surface are marked by fine radiating striæ. The shell is formed of several thin layers or lamellæ, those of the anterior and lateral portions being more or less oblique to the outer surface layer; the shell is also thickened in the visceral region by irregular additions on the inside. The average length of the ventral valve is 2 to 2.5 mm.; the dorsal is a little shorter. The interior of the ventral valve shows a cardinal scar on each side well out toward the lateral margin, which corresponds to the position of the transmedian and anterolateral scars in *Obolus apollinis*. The visceral area is small and compressed between the sinuses occupied by the large, main vascular canals. The inner opening of the pedicle tube is oval and situated at the posterior portion of the visceral depression at the margin of the area. The main vascular canals start near the beak and gradually diverge toward the anterolateral margins of the valve. The interiors of the dorsal valve associated with the two ventral valves illustrated are all so imperfect that only a median ridge like that in *Acrotreta* can be clearly determined; this ridge varies greatly in size and length in different specimens.

Observations.—In a hasty examination of this species [1884b, p. 13] I confused the dorsal valve with that of *Acrotreta* and considered the ventral valve as the type, placing it under *Lingulepis*, stating that it had nearly the same vertical range and geographic distribution as *Obolus mæra*. As now known it is confined to the following localities, one of the two being the locality discovered by the geologists of the Fortieth Parallel Survey.

The generic reference is somewhat doubtful on account of our limited knowledge of the interior of the dorsal valve and the position of the area of the ventral valve.

Formation and locality.—**Ordovician: (313k)** Limestone in the White Pine district, Nye County, Nevada. **Upper Cambrian: (313h)** *Sandy shale on Hamburg Ridge, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.*

Linnarssonella modesta Walcott.

Plate LXXVIII, figures 8, 8a–f.

Linnarssonella modesta Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 90–91, Pl. IX, figs. 8 and 8a. (Described and discussed as below as a new species. Figs. 8 and 8a are copied in this monograph, Pl. LXXVIII, figs. 8 and 8e, respectively.)

Shell minute; general form subcircular. Ventral valve moderately convex; beak small and slightly incurved over a very low false area; pedicle opening minute exteriorly, with a slightly elevated, sharp ridge on each side a little in advance of the point of the beak; seen from the back, the minute aperture points backward from the bottom of a pit between the two short, sharp ridges; in a specimen from a layer of limestone a short distance above in the section, the aperture is at the point of a small nipple-like projection, apparently formed by the union of the ends of the ridges already described on each side of the aperture. Dorsal valve slightly convex, with a minute beak at the posterior margin.

Surface dull when the outer layer of the shell is preserved; it is marked by a few very fine, concentric lines of growth. The inner surface is marked by concentric lines and a few fine radiating lines. The shell is formed of several layers or lamellæ and is relatively thin.

The average diameter of the adult shell is from 1.75 to 2.25 mm.; the dorsal valve slightly shorter than the ventral.

The cast of the interior of the ventral valve shows a slight, longitudinal, median elevation and two short, not very strongly marked main vascular sinuses; several specimens indicate a slight cavity just beneath the aperture, which probably represents the inner side of the pedicle tube. The interior of a dorsal valve shows main vascular sinuses quite close to the outer margin; also two small, rounded median depressions a short distance in front of the posterior margin.

Observations.—This shell occurs in great abundance on the surface of shaly, gray limestone, about midway of the strata referred to the Upper Cambrian in the House Range

section. It differs from *L. nitens*, which occurs a short distance above it in the section, and with which it is also associated, in having a less elevated ventral valve and a less convex dorsal valve; and from *L. transversa* in being more rounded in outline and less convex. It appears to be more nearly related in form to *L. minuta* (Hall and Whitfield); it differs, however, materially in the character of the interior markings of the ventral valve, features which also separate it from *L. girtyi* Walcott and *L. tennesseensis* Walcott.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**30k**) *1,150 feet (350.5 m.) above the Middle Cambrian and 2,175 feet (662.9 m.) below the top of the Upper Cambrian, at the top of the arenaceous shales and limestones forming 1e of the Orr formation [Walcott, 1908f, p. 176];* and (**31t**) about 1,175 feet (358.1 m.) above the Middle Cambrian and 2,150 feet (655.3 m.) below the top of the Upper Cambrian, in the limestone forming 1d of the Orr formation [Walcott, 1908f, p. 176]; both on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah.

LINNARSSONELLA NITENS Walcott.

Plate LXXVIII, figures 7, 7a.

Linnarssonella nitens WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 91, Pl. IX, fig. 7. (Discussed as below as a new species. Fig. 7 is copied in this monograph, Pl. LXXVIII, fig. 7.)

The outline of the valves and the exterior appearance of this shell are much like those of *L. modesta*. It differs in having on the ventral valve a low, distinct area, with the perforated apex directed backward on nearly the same plane as the umbo, or most elevated portion of the valve. The dorsal valve is more convex and its interior has a strong median ridge extending forward from the posterior margin about two-thirds of the distance to the front margin, a feature but little developed in *L. modesta*. From *L. minuta* (Hall and Whitfield) it differs in the higher apex of the ventral valve, and from *L. transversa* in the latter character and in the more circular outline of the aperture of the valves.

A single specimen of *L. modesta* was found associated with this species.

In size *L. nitens* varies from 1.5 to 2 mm. in diameter.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**31t**) *About 1,175 feet (358.1 m.) above the Middle Cambrian and 2,150 feet (655.3 m.) below the top of the Upper Cambrian, in the limestone forming 1d of the Orr formation [Walcott, 1908f, p. 176], on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County;* and (**32g**) about 2,575 feet (784.9 m.) above the Cambrian quartzitic sandstones, in a blue limestone about 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range, Tooele County; both in Utah.

LINNARSSONELLA TENNESSEENSIS Walcott.

Plate LXXIX, figures 3, 3a–k.

Linnarssonella tennesseensis WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 604–605. (Described and discussed as below as a new species.)

Meekina prima WALCOTT, 1905, idem, vol. 28, p. 313. (Name referred to, but it was not defined or used elsewhere.[a])

General form of ventral valve rounded subtriangular, moderately convex, with the beak curving gently over a very low false area nearly to the posterior margin. Pedicle opening minute and situated a little in front of the beak.

Surface of shell marked by fine concentric striæ and lines of growth. The interior surface shows a few fine, radiating striæ. Shell rather thick and built up of several thin layers or lamellæ.

The cast of the interior of the ventral valve shows small cardinal scars and a minute pedicle tube directed backward, very much as in *Obolella atlantica* Walcott (Pl. LV, figs. 1f–h). The area is short, narrow, and divided by a deep, narrow pedicle furrow; on each side of the latter the area projects into the valve so as to form a shelf, with a thickening at the interior angle next to the pedicle furrow; the central visceral area is confined mainly to the deep median groove; an elevated area about the anterior end of the groove probably served as the point of attachment of the central muscle; the main vascular sinuses are very strong and project well toward the front part of the valve; the composite cardinal muscle scars, which served

[a] A shell is referred to as *Meekina prima*, but before the generic or specific description was published I found that the specimens were casts of the interior of *Linnarssonella tennesseensis*.

as the point of attachment of the transmedian and anterior laterals, are situated close to the posterior lateral margin of the valve.

The dorsal valve has a very short and narrow area, with a small but distinct slightly concave shelf-like projection in front of it; on each side near the posterior lateral margins a strongly defined cardinal posterior muscle scar occurs that served as the point of attachment of the transmedian, outside lateral, and middle lateral muscles. The central scars are a little in advance of the center of the valve. None of the specimens show the main vascular canals except at their base. The shells average about 3 mm. in diameter.

Observations.—The material representing this species occurs as casts of the interior and exterior surfaces, in a fine argillaceous shale. It is owing to the removal of the shell substance by solution that the cast of the area and area-like shelf of the dorsal valve is so clearly shown, also the posterior muscle scars, visceral area, etc., of the ventral valve.

The shell has the general outline of *Linnarssonella girtyi* Walcott; but it differs in having the ventral valve more acuminate, less convex, and in the apex curving over nearly to the posterior margin. It has the outline of *L. minuta* (Hall and Whitfield), but not the strong vascular sinuses and small cardinal scars of the ventral valve of that species.

The perforate ventral valve and large cardinal muscle scars relate this species to *Linnarssonella.* The composite cardinal muscle scars, area, and projection of the inner angles of the area into the area of the ventral valve, and also the interior of the dorsal valve, suggest *Dicellomus.* The spondylium-like shelf of the dorsal valve, indicated in the cast, may be only the cast of the area projecting out into the valve (Pl. LXXIX, fig. 1r, of *Linnarssonella girtyi*). The cardinal scars and shelf-like areas of the valve separate this species from *Obolella.*

Formation and locality.—**Upper Cambrian:** (**31t**) About 1,175 feet (358.1 m.) above the Middle Cambrian and 2,150 feet (655.3 m.) below the top of the Upper Cambrian, in the limestone forming 1d of the Orr formation [Walcott, 1908f, p. 176], on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah.

Middle Cambrian: (**13**) *Sandstones of the Rome formation, 1.5 miles (2.4 km.) east of Post Oak Springs [Hayes, 1894, areal geology sheet], Roane County;* (**107b**) shales in railroad cut in Bull Run, northwest of Copper Ridge [Keith, 1896b, areal geology sheet], 11 miles (17.6 km.) northwest of Knoxville, Knox County; and (**12**) sandy shale on Webbs Ridge in gap west of Simpson's farm, 6 miles (9.6 km.) northeast of Knoxville, Knox County; all in Tennessee.

Linnarssonella transversa Walcott.

Plate LXXVIII, figures 6, 6a–c.

Linnarssonella transversa Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 92, Pl. IX, fig. 6. (Discussed as below as a new species. Fig. 6 is copied in this monograph, Pl. LXXVIII, fig. 6.)

This is a small shell that at first sight suggests *L. modesta;* it differs from that species in the valves being more convex, transverse instead of circular, and in having stronger concentric striæ, and, in some instances, radiating striæ. A few fragments of the interior of the dorsal valve indicate that the main vascular sinuses are well out toward the outer margin, and that small circular depressions occur on each side of the median line, very much as in the dorsal valve of *L. girtyi* Walcott (Pl. LXXIX, fig. 1r), and that two small central muscle scars are midway between the posterior and anterior margins of the valve. The average shell has a width of 2 mm., with a length of from 1.5 to 1.75 mm.

L. transversa differs by its transverse outline from all other known species of the genus.

Formation and locality.—**Upper Cambrian:** (**30j**) About 950 feet (289.6 m.) above the Middle Cambrian and 2,450 feet (746.8 m.) below the top of the Upper Cambrian, near the base of the arenaceous shales and limestone forming 1e of the Orr formation [Walcott, 1908f, p. 176], on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah.

Linnarssonella urania Walcott.

Plate LXXVIII, figures 9, 9a–c.

Linnarssonella urania Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 92–93, Pl. IX, figs. 9 and 9a. (Described and discussed as below as a new species. Figs. 9 and 9a are copied in this monograph, Pl. LXXVIII, figs. 9a and 9c, respectively.)

Shell minute, general form elongate oval. Ventral valve convex; apex minute and curved down nearly to the plane of the margin of the valve; false area, if present, must be very narrow.

Pedicle opening situated on the umbo a short distance above the point of the beak; on some shells it opens on the plane of the surface of the valve, and on others it has a rounded, slightly elevated margin. Dorsal valve slightly convex, with a minute beak at the posterior margin. Surface of the shell glossy, with very fine concentric striæ and lines of growth. A ventral valve 2.5 mm. in length has a width of 1.75 mm. The dorsal valves are somewhat shorter in proportion to the width.

A partial cast of the interior of the ventral valve shows a small visceral area in front of the pedicle opening. The interior of the dorsal valve is marked by a strong central ridge that extends from the beak four-fifths of the distance to the front margin; on each side of the median ridge, near the posterior margin, there is a rather large, clearly defined cardinal muscle scar.

Observations.—This species differs from *L. girtyi* Walcott in not having a false area in the ventral valve, and also in the position of the pedicle opening. The incurved apex is more like *L. modesta*, but the form of the ventral valve and the position of the pedicle aperture are quite different.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**55u**) Limestones about 200 feet (61 m.) above the Lower Cambrian [see Walcott, 1908f, p. 171], 0.25 mile (0.4 km.) below the Maxfield mine, in Big Cottonwood Canyon, on the west front of the Wasatch Mountains, southeast of Salt Lake City, Salt Lake County, Utah.

Genus ACROTRETA Kutorga.[a]

[ἄκρος, at the top; and τρητός, bored through.]

Acrotreta KUTORGA, 1848, Verhandl. Russ.-kais. min. Gesell. St. Petersburg for 1847, No. 12, pp. 259 and 260 (notes on genus), and p. 275 (described in German as a new genus; see p. 672 for translation).

Acrotreta Kutorga, MORRIS, 1849, Annals and Mag. Nat. Hist., 2d ser., vol. 4, pp. 316 and 318. (Characterized and discussed.)

Acrotreta Kutorga, DAVIDSON, 1853, British Fossil Brachiopoda, vol. 1, Introduction, No. 3, p. 133. (Described and discussed as a possible subgenus.)

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[a] The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Acrotreta* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Discina Shumard [1861, p. 221].
Acrotreta Billings [1865a, p. 216].
Obolella Salter [1866, p. 285].
Discina Salter [1866, p. 285].
Obolella Hartt [1868, p. 644].
Lingula Barrande [1868a, p. 102; 1868b, p. 692].
Obolella Davidson [1868, pp. 309 and 310].
Acrotreta? Davidson [1868, p. 314].
Obolella Davidson [1871, pp. 339 and 340].
Obolella? Billings [1872b, p. 470].
Acrotreta Meek [1873, p. 463].
Obolella? Billings [1874, p. 69].
Metaptoma Callaway [1874, p. 196].
Acrotreta White [1874, p. 9].
Acrotreta Linnarsson [1876, p. 16].
Obolella Linnarsson [1876, p. 19].
Acrotreta Linnarsson [1877, p. 374].
Acrotreta White [1877, p. 53].
Obolella Callaway [1877, p. 669].
Acrotreta Swanston [1877, Pl. VII figs. 21a–c].
Obolella Hartt [1878, p. 644].
Obolella Linnarsson [1879, p. 27].
Obolus? Barrande [1879b, Pl. XCV: II].
Acrotreta Barrande [1879b, Pl. XCV: VII].
Acrotreta Brögger [1882, pp. 45 and 46].
Obolella Davidson [1883, p. 211].
Acrotreta Davidson [1883, p. 213].
Obolella Walcott [1884a, p. 16].
Obolella? Walcott [1884b, Pl. I, fig. 1c].
Acrotreta Walcott [1886b, p. 98].
Lingulella? Matthew [1886, p. 33].
Acrotreta Matthew [1886, p. 36].
Acrotreta Swanston [1886, Pl. VII, figs. 21a–c].
Linnarssonia Walcott [1887, p. 189].
Linnarssonia Gehlert [1889, p. 1138].
Linnarssonia Walcott [1889b, p. 36].
Obolella Dawson [1888a, p. 55; 1888b, p. 55].
Acrotreta Walcott [1889c, p. 441].
Linnarssonia Walcott [1889c, p. 442].
Obolella (*Linnarssonia*) Dawson [1890, p. 53].
Linnarssonia Hall [1890, p. 55].
Obolella Hartt [1891, p. 644].
Acrotreta Walcott [1891a, p. 608].
Linnarssonia Walcott [1891a, p. 616 and Pl. LXVIII, figs. 2a–d].
Obolella Hall and Clarke [1892c, p. 103].
Acrotreta Matthew [1892, p. 43; 1894, p. 87].
Linnarssonia Matthew [1895a, p. 125].
Acrotreta Matthew [1895a, p. 126].
Lingulella? Matthew [1895a, p. 127].
Obolella Wallerius [1895, p. 65].
Acrotreta Wallerius [1895, p. 66].
Linnarssonia Matthew [1897, p. 169].
Linnarssonia Schuchert [1897, p. 262].
Linnarssonia Frech [1897, Pl. IA, figs. 3a and 3b].
Lingulella? Matthew [1898a, p. 128].
Acrotreta Walcott [1899, p. 449].
Acrotreta Matthew [1901a, p. 275].
Acrothyra? Matthew [1901b, p. 304].
Acrotreta Matley [1902, p. 142].
Acrotreta? Matley [1902, p. 143].
Acrotreta Matley [1902, p. 144].
Linnarssonia Matley [1902, p. 145].
Lingulella (*Acrothyra?*) Matthew [1902b, p. 390].
Acrothele Matthew [1902b, p. 404].
Acrotreta Matthew [1902c, p. 109].
Acrotreta Walcott [1902, pp. 580–600].
Acrotreta Wiman [1902, pp. 54 and 55].
Obolella Wiman [1902, p. 66].
Acrothele Matthew [1903, p. 103].
Acrotreta Walcott [1905a, pp. 298–303].
Acrotreta Moberg and Segerberg [1906, pp. 64, 65, and 66].
Acrotreta Walcott [1908c, p. 245; 1908d, pp. 93, 94, 95, and 96].

Acrotreta Kutorga, von Seebach, 1865, Zeitschr. Deutsch. geol. Gesell. for 1865, Bd. 17, Hft. 2, p. 341. (Discussed in German.)

Acrotreta Kutorga, Davidson, 1871, British Fossil Brachiopoda, vol. 3, pt. 7, No. 4, p. 343. (Mentioned in discussion of *Acrotreta nicholsoni*.)

Acrotreta Kutorga, Dall, 1877, Bull. U. S. Nat. Mus. No. 8, p. 12. (Mentioned.)

Acrotreta Kutorga, Zittel, 1880, Handbuch der Palæontologie, Bd. 1, Abth. 1, p. 666. (Described in German.)

Acrotreta Kutorga, Walcott, 1884, Mon. U. S. Geol. Survey, vol. 8, pp. 16–17. (Discussed.)

Linnarssonia Walcott, 1885, Am. Jour. Sci., 3d ser., vol. 29, p. 115. (Described and discussed as a new genus.)

Linnarssonia Walcott, Matthew, 1886, Trans. Roy. Soc. Canada for 1885, 1st ser., vol. 3, sec. 4, No. 4, p. 35. (Discussed.)

Acrotreta Kutorga, Oehlert, 1887, Manuel de conchyliologie, by Fischer, p. 1266. (Described in French, with figures of "*A. subconica.*")

Linnarssonia Walcott, Dawson, 1890, Trans. Roy. Soc. Canada for 1889, 1st ser., vol. 7, sec. 4, No. 3, pp. 53–54. (Mentioned in discussion of *Acrothele pretiosa*.)

Acrotreta Kutorga, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 250. (Described.)

Linnarssonia Walcott, Hall and Clarke, 1892, idem, p. 251. (Described.)

Acrotreta Kutorga, Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, p. 566. (Copied from Hall and Clarke, 1892a, p. 250.)

Linnarssonia Walcott, Hall and Clarke, 1892, idem, p. 567. (Copied from Hall and Clarke, 1892a, p. 251.)

Acrotreta Kutorga, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 101–104. (Described and discussed.)

Linnarssonia Walcott, Hall and Clarke, 1892, idem, pp. 107–109. (Described and discussed.)

Linnarssonia Walcott, Matthew, 1892, Trans. Roy. Soc. Canada for 1891, 1st ser., vol. 9, sec. 4, No. 5, p. 42. (Species referred to the genus mentioned.)

Acrotreta Kutorga, Matthew, 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 5, No. 20, p. 390. (Stratigraphic range in Cape Breton discussed.)

Acrotreta Kutorga, Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 94. (A copy of the preceding reference.)

Acrotreta Kutorga, Matthew, 1903, idem, pp. 96–97. (Notes on development of the genus.)

Acrotreta Kutorga, Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 199. (Described.)

? Linnarssonia Grabau and Shimer, 1907, idem, p. 200. (Described, but the only species referred to the genus ("*L. pretiosa*") is not figured and it is impossible to tell whether the authors are discussing the *Linnarssonia pretiosa* that has been referred to the genus *Acrotreta* (*Acrotreta sagittalis*), or to the genus *Acrothele* (*Acrothele pretiosa*).)

Acrotreta Kutorga, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 146. (Classification of genus.)

The original description by Kutorga follows:

Dorsal valve highly conical; the hinge surface of the cone flat, in the form of a high triangle, similar to an area, with a shallow gutter-shaped depression running from the tip as far as the middle point, which (depression) here appears as an indication of a deltidium. At the upper end of this furrow, turned consequently to the hinge side, is found the obtusely oval external siphonal opening.

Ventral valve flat, with a distinct marginal apex. On the surface of the shell are seen only delicate growth wrinkles concentric to the apex of the cone, which curve crescentially into the longitudinal furrow of the surface of the shell; no tubercles and no spines; hinge border rectilinear.

The revised description of the genus is as follows: Ventral valve strongly convex to conical, with the posterior face more or less flattened to form a false area that is usually marked by a shallow median groove. Pedicle opening at the apex of the cone and directed more or less backward. Apex usually anterior to the posterior margin, but occasionally overhanging it. Dorsal valve slightly convex, with very small beak; area short and divided by a small false deltidium.

Surface marked by fine concentric striæ and lines of growth which cross the posterior face and the median groove; in addition there are on five species very fine, concentric, undulating, often inosculating, rounded ridges that form a surface like that of *Obolus* (*Westonia*) *ella* (Hall and Whitfield) (Pl. XLVII, fig. 10). *Acrotreta primæva* Walcott (Pl. LXIX) has this type of surface. *A. claytoni* Walcott (Pl. LXXIV) has fine, undulating striæ, *A. spinosa* Walcott (Pl. LXXIX) fine short spines, and *A.? cancellata* Walcott (Pl. LXXIX) a cancellated surface. The shell in all species where it is preserved is calcareocorneous and built up of several thin layers or lamellæ that are arranged more or less obliquely to the outer surface toward the outer margin of the valves.

The cast of the ventral valve shows that the interior of the shell has a rather strong callosity or apical swelling penetrated by the foraminal tube, and on each side of and back of the callosity near the posterior margin the cardinal muscle scars, which usually take the form of a projecting boss or tubercle corresponding to a depression in the shell in which the transmedian and middle lateral muscles were probably attached. In front of the apical callosity in *A. argenta* Walcott there are two trapezoidal areas corresponding to similar areas in *Obolella* and *Obolus*, in which the central, outside, and middle lateral muscles were attached. The position and size of the areas are shown by Plate LXVII, figures 5a and 5b. The grooves of the main vascular sinuses pass around the apical swelling and extend forward, diverging toward the anterolateral margins of the shell.

The interior of the dorsal valve is almost invariably marked by a long, well-defined median ridge and a pair of strong cardinal tubercles near the margin of the area corresponding in position to the cardinal tubercles of the ventral valve. Smaller tubercles occur in advance of the posterior tubercles, one on each side of the median ridge; they are often replaced by elongate oval scars that correspond to the central scars of the dorsal valve of *Obolus;* the anterior lateral muscle scars are too minute to be clearly located, but they were undoubtedly close to the median line a little in advance of the central scars. The cardinal tubercles of both valves often have scars on them indicating the attachment of muscles.

Type.—Acrotreta subconica Kutorga.

Observations.—Of the type of the genus, *A. subconica* Kutorga, only the external shell is known. In 1884 [1884b, Pl. I, figs. 1b and 1d] I illustrated the interior of both valves of "*A. gemma*" (see pp. 30–31), showing the area, median ridge, "cardinal tubercles," and central muscle tubercles of the dorsal valve, and the apical swelling and cast of the main vascular canals in the ventral valve. Matthew [1886, Pl. V, figs. 13 and 13c] illustrated the interior of *A. baileyi*, showing the cast of a small tubercle on each side of the apical swelling. Hall and Clarke [1892c, p. 102] stated that they could not see the cast of these tubercles on the original specimen, and I have not been able to find them on any of the type specimens of *A. baileyi* received from Matthew. It frequently occurs that the casts of the short deep channel of the main vascular sinuses give rise to tubercles a little in advance of and close to the apical callosity (Pl. LXX, fig. 1f), or it may be that the cast of the visceral cavity will take the form of tubercles in front of the cast of the apical callosity (Pl. LXIV, fig. 2c).

The intimate relations existing between *Acrotreta* and *Linnarssonia* became more and more apparent with the collection of better material representing the two species referred to the two genera. Girty, when selecting specimens for illustration, called my attention to the strong resemblance between them and suggested that *Linnarssonia* was a synonym of *Acrotreta*. In all essential characters this is true, and *Linnarssonia*, if retained at all, must be as a subgenus to include the depressed forms of *Acrotreta*, intermediate between the typical elevated species *A. subconica* Kutorga and *A. gemma* Billings and the nearly flattened shells of *Acrothele*. In view, however, of the close similarity of the interiors of the valves of *Acrotreta schmalenseei* Walcott, *A. curvata* Walcott, and *A. kutorgai* Walcott to "*Linnarssonia transversa*" (see *Acrotreta sagittalis transversa* (Hartt)), "*L.*" *sagittalis* (Salter), and "*L.*" *misera* (Billings) there remains only the external form of the pedicle valve to distinguish the two genera; this latter character is not of generic importance in the presence of the gradation in elevation and outline between *A. subconica* Kutorga and *A. sagittalis transversa* (Hartt), shown by *A. idahoensis* Walcott, *A. schmalenseei* Walcott, *A. microscopica* (Shumard), *A. pyxidicula* White, and *A. sagittalis* (Salter).

When studying the specimens of *Acrotreta* at hand in 1884 I believed that *A. gemma* Billings, of Newfoundland, included the western forms described by Meek [1873, p. 463] and White [1877, p. 53]. This conclusion was retained until the study of a large series from each of the typical localities convinced me that there were a number of species and varieties grouped under *A. gemma*. The correct reference of these species and varieties is indicated in the table, pages 30–31, and taken up in detail in the synonymy of each of the different species.

"*Acrotreta? costata*" Davidson [1883, p. 213] from the Llandeilo of Scotland does not appear to be an *Acrotreta*. The description and figures suggest a genus allied to *Cyrtia* Hall and Clarke [1894, p. 40] of the Silurian.

The surface characters of *Acrotreta* have been considered to be very simple and confined to concentric lines and striæ of growth and obscure radiating striæ. This study of the species has resulted in the discovery that five species, *A. bisecta* Matthew, *A. gemmula* Matthew, *A. inflata* (Matthew), *A. primæva* Walcott, and *A. sabrinæ* (Callaway), have a surface much like that of *Obolus* (*Westonia*) *ella* (Hall and Whitfield) (Pl. XLVII). Mention has been made of the cancellated and spinose species, and those with undulating concentric striæ. It is evident that *Acrotreta*, like *Acrothele* and *Micromitra*, has varied surface characters that are of specific but not generic value.

The false area, with or without its vertical median groove, is a variable character. The area and median groove are well developed in the type *A. subconica* Kutorga (Pl. LXXIII, figs. 2g, 2h) and in the species *A. socialis* v. Seebach (Pl. LXXIII, figs. 4′, 4a′). On *A. attenuata* Meek a narrow sharp furrow is present, but the false area is scarcely defined (Pl. LXIV, figs. 1b″, 1c″, 1d″). On *A. idahoensis* Walcott the false area is clearly defined but there is scarcely a trace of the median furrow (Pl. LXV, figs. 1″, 1a″–c″). On *A. microscopica* (Shumard) (Pl. LXVII, figs. 1a′–c′) there is only a faint false area and no median groove.

The vascular markings, muscle scars, and apical callosity of the ventral valve vary in relative size, position, and appearance, but they all have a common general character and position. Usually the markings on the interiors of the valves are very faint, and often nothing can be seen but the apical callosity and the base of the main vascular sinuses in the ventral valve, and the median ridge in the dorsal valve. It would require many pages on which to record the variations, and as they are illustrated by the figures on the plates I will not attempt it.

Geographic distribution.—The little shell of *Acrotreta* occurs in every country where any considerable development of the Cambrian fauna is known. The exceptions are northern India, Australia, and where the Lower Cambrian fauna predominates. The general distribution is given on pages 105–106.

Stratigraphic distribution.—Three species and one variety are known from the Lower Cambrian, one of which, *A. primæva* Walcott (Pl. LXIX, figs. 1, 1a–f), is one of the largest species of the genus. From the Middle Cambrian thirty-three species and ten varieties are known; they range from the base of the terrane to its summit, and two, *A. idahoensis* Walcott and its variety *alta* and *A. pyxidicula* White, pass up into the Upper Cambrian, and the first species and its variety *alta* continue on up into the base of the Ordovician in Nevada. In the Upper Cambrian twenty-one species and three varieties are known and in the passage beds above seven species. In the Lower Ordovician seven species and one variety occur, of which one species and one variety also occur in the Cambrian. The stratigraphic range of the species is given on pages 105–106.

Acrotreta argenta Walcott.

Plate LXVII, figures 5, 5a–g.

Acrotreta argenta Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 580–581. (Described as below as a new species.)

The material representing this species is more or less crushed and broken, but a few specimens show the general form and characters. It belongs to the *Acrotreta idahoensis* Walcott group in having a wide false area, strongly marked apical callosity, and pedicle opening. The thickening in the posterior portion of the dorsal valve is also characteristic of the two species.

The cast of the interior of a ventral valve (Pl. LXVII, fig. 5b) reveals what I have searched for unsuccessfully in hundreds if not thousands of specimens of this genus. I refer to the visceral area with the position of the point of attachment of the central and lateral muscles on each side of it, essentially as in *Obolella* and *Obolus* (Pl. VII).

Formation and locality.—**Upper Cambrian**: (7x and 7y) Limestone of the Emigrant formation [Turner, 1902, p. 265], about 2.5 miles (4 km.) southeast of Emigrant Pass; (8b′) *shales of the Emigrant formation* [*Turner, 1902, p. 265*],

in a ravine on the east side of the road about 1 mile (1.6 km.) southwest of Emigrant Pass; and (7v) shales of the Emigrant formation [Turner, 1902, p. 265], 4.25 miles (6.8 km.) south-southeast of Emigrant Peak; all in the Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County, Nevada.

Acrotreta attenuata Meek.

Plate LXIV, figures 1, 1a–o; Plate LXXIX, figures 6, 6a.

Acrotreta attenuata Meek (in part), 1873, Sixth Ann. Rept. U. S. Geol. and Geog. Survey Terr. for 1872, p. 463, footnote. (Listed as *A. subconica* Kutorga, and described in footnote as a possible new species. Specimens now referred to *A. attenuata* var.? and *A. idahoensis* were also included in this reference.)

Acrotreta gemma Walcott (in part) [not Billings], 1884, Mon. U. S. Geol. Survey, vol. 8, pp. 17–18. (Specimens representing *Acrotreta pyxidicula*, *A. curvata*, and *A. idahoensis alta* were included with the specimens representing *A. attenuata* when this description of *A. gemma* was written, but only the last two are known to have been figured: *A. curvata*, Pl. I, figs. 1d and 1e; and *A. idahoensis alta*, Pl. I, figs. 1a and 1b. The specimens represented by Pl. IX, figs. 9 and 9a, can not be found at this time, but it is probable that they should be referred to *A. idahoensis alta*. Fig. 1c represented a specimen of *Acrotreta sabrinæ*, and the specimen represented by fig. 1f is missing.)

Acrotreta gemma Walcott (in part) [not Billings], 1886, Bull. U. S. Geol. Survey No. 30, pp. 98–99. (Specimens now referred to *Acrotreta pyxidicula* and *A. primæva* were included with the specimens representing *A. attenuata* when this description of *A. gemma* was written, *A. primæva* being figured, Pl. VIII, figs. 1, 1a–b.)

Acrotreta gemma Walcott (in part) [not Billings], 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 608. (Specimens now referred to *Acrotreta pyxidicula*, *A. curvata*, *A. idahoensis alta*, and *A. primæva* were included with the specimens representing *A. attenuata* in this reference to *A. gemma*, the last three being figured: *A. curvata*, Pl. LXVII, fig. 5b; *A. idahoensis alta*, Pl. LXVII, figs. 5 and 5a; and *A. primæva*, Pl. LXVII, figs. 5c, 5d, and 5e.)

Acrotreta gemma Walcott (in part) [not Billings], 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, p. 449. (Specimens now referred to *Acrotreta pyxidicula*, *A. curvata*, *A. idahoensis alta*, and *A. primæva* were included with the specimens representing *A. attenuata* when this description of *A. gemma* was written, the last three being figured: *A. curvata*, Pl. LXII, fig. 2e; *A. idahoensis alta*, Pl. LXII, figs. 2a and 2c; and *A. primæva*, Pl. LXII, figs. 2, 2b, and 2d.)

Acrotreta attenuata Meek, Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 298. (Characterized.)

The variations in the exterior form of the ventral valve of this species are so fully shown by the illustrations that it is unnecessary to enter into detailed description. The species is characterized by its elevated ventral valve and narrow, incurved false area. The specimens illustrated by Plate LXIV, figures 1, 1a, 1b, and 1h, are from the material labeled by Meek as *Acrotreta attenuata*, and all the others are from the same geological area. Some of the forms of *A. idahoensis alta* (Pl. LXV, fig. 4) look like *A. attenuata*, but the false area is different. *Acrotreta kutorgai* has a somewhat similar false area and elevation, but it is a less robust shell and the apex of the ventral valve is nearer the posterior margin. The former reference to *A. gemma* is explained under the description of the genus (p. 673). Shells with a distinctly marked false pedicle groove in the ventral valve occur in the shales of the Wheeler formation of the Middle Cambrian of the House Range, Utah. The shells of this locality show fine interiors of both valves (Pl. LXIV, figs. 1i–n, and Pl. LXXIX, figs. 6, 6a). The interiors of the ventral valve are much like those of *A. kutorgai* Walcott (Pl. LXV, figs. 3b, 3c).

Formation and locality.—**Upper Cambrian**: (**61**) Limestone in the Dunderberg shale [Walcott, 1908f, p. 184], a little south of the Hamburg mine, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

Middle Cambrian: (**59**) Limestone at the base of the western slope of Combs Peak, near the plain of Antelope Valley, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

(**3s**) About 1,700 feet (518.2 m.) above the Lower Cambrian and 2,700 feet (823 m.) below the Upper Cambrian in the shaly limestones and calcareous shales of the Wheeler formation [Walcott, 1908f, p. 181] in the eastern part of Wheeler Amphitheater, east of Antelope Springs, House Range [Walcott, 1908f, Pls. XIII and XV]; (**10y**) about 2,900 feet (884 m.) above the Lower Cambrian and 1,500 feet (457.2 m.) below the Upper Cambrian in the central part of the limestone forming 1a of the Marjum limestone [Walcott, 1908f, p. 179], about 1 mile (1.6 km.) south-southwest of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII]; and (**3x**) about 2,200 feet (670.6 m.) above the Lower Cambrian and 2,200 feet (670.6 m.) below the Upper Cambrian in the shaly limestoues forming 1d of the Marjum limestone [Walcott, 1908f, p. 180], 2.5 miles (4 km.) east of Antelope Springs, in ridge east of Wheeler Amphitheater, House Range [Walcott, 1908f, Pls. XIII and XV]; all in Millard County, Utah.

(**9h**) At the base of the limestone above the Wolsey shale [Walcott, 1908f, p. 202] on Beaver Creek, 5 miles (8 km.) north of York, and about 8 miles (12.8 km.) north of Canyon Ferry, Big Belt Mountains, Fort Logan quadrangle (U. S. Geol. Survey), Meagher County; (**159**) limestones north of West Gallatin (Gallatin) River, Gallatin County; (**302**)

limestones on the east side of West Gallatin (Gallatin) River, above Gallatin, Gallatin County; and (**156a**) limestones of the Flathead formation of Peale, north of East Gallatin River, near Hillsdale, Gallatin County; all in Montana.

(**4n**) Limestone about 325 feet (99.1 m.) above the unconformable base of the Cambrian in divide at the head of Jackson Creek (locally known as Sheep Creek), a creek flowing into Jackson Lake about 0.5 mile (0.8 km.) south of its northwest corner, Teton Mountains, Grand Teton quadrangle (U. S. Geol. Survey), Uinta County; and (**340d**) limestone near the head of Bear River Canyon; both in Wyoming.

Acrotreta attenuata var.? Walcott.

Plate LXV, figure 2.

Acrotreta attenuata Meek (in part), 1873, Sixth Ann. Rept. U. S. Geol. and Geog. Survey Terr. for 1872, p. 463, footnote. (These specimens were included by Meek with the specimens which he listed as *Acrotreta subconica* and described in a footnote as *A. attenuata*. See also *A. attenuata* and *A. idahoensis*.)

Acrotreta attenuata Meek, var.?, Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 298. (Reason given for separation as variety.)

A shell with a distinctly marked false area is separated as a variety of *Acrotreta attenuata*. It is associated with the type specimen of *A. attenuata*.

Formation and locality.—**Middle Cambrian:** (**302**) Limestone east of West Gallatin (Gallatin) River, above Gallatin, Gallatin County, Montana.

Acrotreta babel Barrande.

Plate LXXVII, figures 6, 6a–b.

Acrotreta babel Barrande, 1879, Système silurien du centre de la Bohême, vol. 5, pt. 1, Pl. XCV, figs. vii: 1–2. (Not described, but figured as a new species. Figs. 2A, 2B, and 2C are reproduced in this monograph, Pl. LXXVII, figs. 6, 6a–b, respectively.)

This minute species is the only form of this genus that has been identified from Bohemia by Barrande. It has the characters of the genus, and with the figures for comparison with other species it appears to be distinct from all others. Barrande [1879b, Pl. XCV, fig. vii: 1] illustrates a more conical shell from Trubin than that represented by figures 6 and 6a, which may belong to another species and genus.

Formation and locality.—**Lower Ordovician:** (**303**) *Étage d3, Königshof;* and (**303a**) Étage d3, Trubin; both [Barrande, 1879b, Pl. XCV] in Bohemia, Austria-Hungary.

Acrotreta baileyi Matthew.

Plate LXXVII, figures 2, 2a–d.

Acrotreta baileyi Matthew, 1886, Trans. Roy. Soc. Canada for 1885, 1st ser., vol. 3, sec. 4, No. 4, pp. 36–37, Pl. V, figs. 13, 13b–d. (Described and discussed as a new species. The specimens represented by figs. 13, 13c, and 13d are redrawn in this monograph, Pl. LXXVII, figs. 2a, 2, and 2′, respectively.)

Acrotreta baileyi Matthew, Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, Pl. III, figs. 28–30. (Figs. 28 and 30 are drawn from the specimens figured by Matthew, 1886, Pl. V, figs. 13c and 13, respectively.)

Acrotreta baileyi Matthew, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 102, Pl. III, figs. 32–34. (Discussed. Figs. 32–34 are copied from figs. 28, 30, and 29 of the preceding reference.)

Not *Acrotreta baileyi?* Matthew, 1892, Trans. Roy. Soc. Canada for 1891, 1st ser., vol. 9, sec. 4, No. 5, p. 43, Pl. XII, fig. 7d (referred to *A. bisecta*).

Acrotreta baileyi Matthew, 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 5, No. 20, p. 395, Pl. XVI, figs. 1a–d. (Mentioned and dimensions given. Figs. copied from Matthew, 1886, Pl. V, figs. 13, 13b–d.)

Acrotreta baileyi Matthew, Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 581–582. (Described and discussed as below.)

Acrotreta baileyi Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 97, Pl. III, figs. 1a–d. (Mentioned. Figures are copied from Matthew, 1886, Pl. V, figs. 13, 13b–d.)

General outline transversely oval, with the posterior margin more or less straight for less than one-half the transverse diameter of the shell. On the ventral valve the posterior margin is rounded in at the median furrow of the false area, and on the dorsal valve it curves gently from the cardinal slopes to the beak.

The ventral valve is strongly convex with the apex about one-fourth the length of the valve from the posterior margin. The crushed condition of the shells does not permit

decision as to whether the umbo or the apex is the most elevated part of the valve. False area defined by the incurving of the cardinal slopes so as to form a somewhat flattened, triangular space that is divided midway by a rather strong vertical furrow. Pedicle aperture rather large and opening obliquely backward. The dorsal valve is gently convex, with a minute marginal beak.

Surface of shell marked by fine concentric striæ and lines of growth, and possibly by fine radiating striæ. I fail to find any traces of the radiating striæ on specimens that have not been distorted by pressure, and it looks as though all radiating striæ and lines are the result of lateral compression of the shell. The average length is about 3.5 mm.; width, 4 mm. (Distorted shells have a length of 4 mm.; width, 3 mm.)

The cast of the interior of the ventral valve shows a strong apical callosity, a fair-sized pedicle opening, large cardinal scars, and a small visceral area in front of the apical callosity. Matthew [1886, p. 36, Pl. V, fig. 13c] describes and shows on his illustration two "minute muscle scars" close to the "umbonal tubercle" and on each side of the parallel striæ. On one specimen I find what may have led Matthew to consider there were such scars, but on many others quite as well preserved there are no such indications, and they are not known in any other species of the genus. Hall and Clarke examined Matthew's type material, and stated [1892c, p. 102] that with the original material before them they were unable "to distinguish anything more than the central callosity." The cast of the interior of the dorsal valve shows a strong median ridge of variable length and size, large cardinal scars, and well-defined central scars.

Observations.—This species belongs with the series represented by *A. sagittalis* (Salter) and its varieties, and if uncompressed, nondistorted, well-preserved specimens could be obtained, it is quite possible that it would prove to be identical with *A. sagittalis transversa* (Hartt). Matthew [1886, p. 37] thinks it has a thinner shell, but that is not probable, as the apical callosity and cardinal scars of the ventral valve and the median ridge, cardinal and central scars of the dorsal valve all indicate a shell quite as thick as that of *A. sagittalis* and its varieties.

Doctor Matthew kindly sent me the type and study material of this species from his private collection.

FORMATION AND LOCALITY.—**Middle Cambrian: (300)** *Shaly sandstones, possibly of Division 1d of Matthew, on Long Reach, Kings County;* and **(301)** doubtfully in sandstones of Division 1b2 of the "*Protolenus* zone" [Matthew, 1895a, p. 108] Hanford Brook, St. John County; both [Matthew, 1886, p. 37] in New Brunswick, Canada.

ACROTRETA BELLATULA Walcott.

Plate LXXVIII, figures 4, 4a–d.

Acrotreta bellatula WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 93–94, Pl. IX, figs. 4, 4a–b. (Described and discussed as below as a new species. Figs. 4, 4a–b are copied in this monograph, Pl. LXXVIII, figs. 4, 4b, and 4d, respectively.)

General outline subcircular to transversely broad oval, with the posterior margin of the ventral valve nearly straight beneath the false area. The ventral valve is moderately convex, with the apex a little in front of the posterior margin. False area defined by the incurving of the cardinal slopes so as to form a somewhat flattened triangular space that is divided midway by a narrow and rather shallow, vertical furrow; pedicle aperture of medium size and opening slightly backward. Dorsal valve nearly as convex as the ventral, except that it curves down in the posterior portion to a minute marginal beak.

Surface of the shell marked by fine, concentric striæ and lines of growth that show marked variations in their sharpness on different specimens, the older shells having a dark, dull surface giving the effect of a thin film over the striæ; a few traces of radiating striæ are shown on some shells.

The average length of the larger shells is about 1.75 mm.; width, 2 mm.

The interior of the ventral valve shows a small apical callosity, minute pedicle tube, and vascular sinuses originating a little back of the apical callosity; a cast shows that there were

medium-sized, elevated cardinal muscle scars. An interior cast of the dorsal valve indicates a median ridge that extended about four-fifths of the distance from the area to the front margin. It also indicates medium-sized, elevated cardinal muscle scars. A second specimen shows a shorter median ridge, with small, elevated central muscle scars about halfway between the posterior and front margins of the shell.

Observations.—This species belongs to the *Acrotreta sagittalis* (Salter) group. The low convexity of the ventral valve, posterior position of the apex, the strong cardinal muscle scars, and the strong median ridge, and the cardinal and central scars of the dorsal valve, are all features common to *Acrotreta bellatula* and *A. sagittalis*. It differs from *A. sagittalis* in the more posterior position of the apex and less convexity of the ventral valve, and from *A. definita* Walcott in its much smaller size and less elevated ventral valve.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**10z**) *About 2,900 feet (884 m.) above the Lower Cambrian and 1,500 feet (457.2 m.) below the Upper Cambrian* in 1a of the Marjum limestone [Walcott, 1908f, p. 179]; (**11n**) a horizon about 100 feet (30.5 m.) above (**10z**); and (**3w**) about 2,350 feet (716.3 m.) above the Lower Cambrian and 2,050 feet (624.8 m.) below the Upper Cambrian in the central portion of 1c of the Marjum limestone [Walcott, 1908f, p. 180], in the long cliff about 2 miles (3.2 km.) southeast of Marjum Pass; both in the House Range [Walcott, 1908f, Pls. XIII and XV], Millard County, Utah.

ACROTRETA BELTI (Davidson).

Plate LXXVII, figures 8, 8a.

Obolella belti DAVIDSON, 1868, Geol. Mag., vol. 5, pp. 310–311, Pl. XV, figs. 25–27. (Described as below as a new species. The specimens represented by figs. 25–27 are redrawn by Davidson, 1871, Pl. L, figs. 15, 17, and 16, respectively, and the last two figures are copied in this monograph; see note accompanying the following reference.)

Obolella belti DAVIDSON, 1871, British Fossil Brachiopoda, vol. 3, pt. 7, No. 4, pp. 340–341, Pl. L, figs. 15–17. (Copy of preceding reference; figs. 15–17 are copied (with slight changes) from figs. 25, 27, and 26, respectively, of the preceding reference. Figs. 16a and 17a are reproduced in this monograph, Pl. LXXVII, figs. 8 and 8a, respectively.)

Obolella sagittalis belti DAVIDSON, 1871, idem, description of figures, opposite Pl. L. (Species placed as a variety without explanation.)

Not *Linnarssonia belti?* MATTHEW, 1892, Trans. Roy. Soc. Canada for 1891, 1st ser., vol. 9, sec. 4, No. 5, pp. 42–43, Pl. XII, figs. 7a–c. (This species is not specifically referred in this monograph.)

Linnarssonia belti (Davidson), MATLEY, 1902, Quart. Jour. Geol. Soc. London, vol. 58, pt. 1, p. 145, figs. 17–18. (Characterized.)

Not *Linnarssonia* cf. *belti* MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 209–210, Pl. XVI, figs. 3a–c. (Copies Matthew, 1892, pp. 42–43, Pl. XII, figs. 7a–c. The species is not specifically referred in this monograph.)

The original description by Davidson follows:

Shell small, less than a line in length by about 1 line in breadth; transversely oval; beak acuminated; front broadly rounded. Valves moderately convex and marked by concentric lines of growth. The internal characters agree pretty closely with those described in *O. sagittalis*.

Observations.—It is possible that with a good series of specimens of this species its relations to other species might be more accurately determined than Doctor Davidson was able to do. It is not probable that *Acrotreta sagittalis* (Salter) persisted into Lower Tremadoc time, but with a genus where the specific characters are so limited and the variations within the same species considerable it is exceedingly difficult to determine the specific relations of a form represented by only a few not very good specimens. *Acrotreta belti* appears to belong to the *A. sagittalis* group of forms, but for the present I think it is quite as well to leave it as a species.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**305** [*Davidson, 1871, p. 341*]) *Lower Tremadoc shales, Craig-y-dinas, North Wales.*

(**304** [Matley, 1902, p. 145]) "Bronsil" shales at White Leaved Oak, Malvern Hills; and (**304a** [Groom, 1902, p. 110]) "Bronsil" shales in the Malvern Hills; both between Herefordshire and Worcestershire, England.

ACROTRETA BISECTA Matthew.

Plate LXVI, figures 7, 7a–e.

Acrotreta baileyi? MATTHEW, 1892, Trans. Roy. Soc. Canada for 1891, 1st ser., vol. 9, sec. 4, No. 5, p. 43, Pl. XII, fig. 7d. (Characterized and discussed.)

Acrotreta bisecta MATTHEW, 1901, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 4, No. 19, pp. 275–276, Pl. V, figs. 5a–g. (Described and discussed as a new species.)

Acrotreta bisecta MATTHEW, 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 5, No. 20, p. 394, Pl. XVI, figs. 2a–g. (Mentioned and figures of preceding reference copied.)

Acrotreta sipo MATTHEW, 1902, idem, pp. 406–407, Pl. XVIII, figs. 1 and 2. (Described and discussed as a new species.)

Acrotreta bisecta Matthew, WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 582. (Described and discussed.)

Acrotreta sipo MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 185–186, Pl. XVIII, figs. 1 and 2. (Copy of Matthew, 1902a, pp. 406–407, Pl. XVIII, figs. 1 and 2.)

Acrotreta bisecta MATTHEW, 1903, idem, pp. 186–187, Pl. XI, figs. 5a–g. (Copy of Matthew, 1901, pp. 275–276, Pl. V, figs. 5a–g.)

Acrotreta bisecta Matthew, WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 298–299. (Described and discussed as below.)

Nearly all the ventral valves of this species are more or less compressed in the shale, thus decreasing the true elevation. Matthew [1903, Pl. XI, fig. 5] illustrates a pointed, high, ventral valve, but does not state whether or not the figure is diagrammatic. Some of the casts in the shale indicate a sharply conical ventral valve. When the apex is broken off the cast of a median apical callosity is seen, with the base of the cast of a medium-sized pedicle tube; the cardinal scars are small and nearly concealed by the cast of the strong main vascular sinuses. There is considerable range of variation in the size and length of the median ridge of the dorsal valve. One specimen (fig. 7d) shows a strong median ridge, cardinal and central scars, and deeply excavated false deltidium. Surface marked by fine concentric striæ and lines of growth and very fine undulating striæ that give the concentric striæ a fretted appearance when examined by a strong lens.

The most nearly related species appears to be *A. sabrinæ* (Callaway) of the Shineton shales. Matthew [1902a, p. 406] has described a shell as "*Acrotreta sipo*" that occurs with his "*Asaphellus* fauna." I am unable to detect any specific differences between it and *A. bisecta*, from the same area.

The specific name is due to the presence of a strong median ridge bisecting the dorsal valve.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**3q**) Shale in Barachois Glen, 4 miles (6.4 km.) south of Little Bras d'Or Lake; (**10l**) shale on east bank of Barachois River, 6 miles (9.6 km.) from Little Bras d'Or Lake; (**10c** and **10d**) shales on west side of Barachois River, 0.125 mile (0.2 km.) north of Boisdale Road, opposite McMullin's place; (**10e**, **10f**, and **10g**) shales on the east branch of Barachois River, 0.5 and 0.75 miles (0.8 and 1.2 km.), respectively, north of the crossroad from Boisdale to Upper Leitches Creek; (**10n**) shale in ravine on east side of Barachois Glen, 3 miles (4.8 km.) from Barachois; (**10h**) shale on small east branch of Barachois River, 0.75 mile (1.2 km.) north of the crossroad from Boisdale to Upper Leitches Creek; (**13h**) shale on east bank of Barachois River, 1.5 miles (2.4 km.) north of Boisdale; (**307a** [Matthew, 1903, p. 186]) shales of Division C3c2 of Matthew, on McLeod Brook=Barachois River; and (**307** [*Matthew, 1903, p. 187*]) *shales of Division C3c of Matthew, on McLeod Brook=Barachois River;* all in eastern Cape Breton, Nova Scotia.

(**308** [Matthew, 1892, p. 43]) Shales of Division C3c of Matthew at Navy Island, St. John Harbor, New Brunswick, Canada.

ACROTRETA ?? CANCELLATA Walcott.

Plate LXXIX, figures 5, 5a.

Acrotreta ?? cancellata WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 299. (Characterized as below as a new species.)

The only specimen of this species in the collection has more the form of *Micromitra* than *Acrotreta*. In its overhanging false area it suggests *Acrothyra*. Whatever the genus to which it belongs may be, its cancellated surface serves to distinguish it from forms with which it might otherwise be compared. The surface is formed by very fine, raised, concentric lines or ridges of growth, crossed by sharp radiating lines, which are seen only between the concentric lines.

FORMATION AND LOCALITY.—**Passage beds** between the Upper Cambrian and the Ordovician: (**205**) Siliceous limestone on Roundtop Mountain, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

ACROTRETA CARINATA (Segerberg MS.) Moberg and Segerberg.

Text figures 56A–D, page 680.

Acrotreta cf. *socialis* BRÖGGER (in part), 1882, Die silurischen Etagen 2 und 3, pp. 46–47, Pl. X, figs. 2, 2a–b (not figs. 3–4, which are not referred in this monograph). (Described in German.)

Acrotreta carinata (SEGERBERG MS.) MOBERG and SEGERBERG, 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), p. 66, Pl. III, figs. 5a–c and 6. (Described in Swedish as a new species; see p. 680 for translation. The figures are reproduced in this monograph as figs. 56A–D, p. 680.)

The original description by Moberg and Segerberg follows:

The species differs from *Acrotreta circularis*, to which in other respects it is closely related, by its more even area, sharply bounded on the sides. At the rectilinear posterior edge the area occupies about one-fourth of the circumference; that is to say, more than in the case of *A. circularis*. The apex is also placed somewhat nearer the posterior edge than in the last-named species. The smaller shell is only feebly arched, with marginal, somewhat overlapping umbo.

By its large well-marked keeled area our species resembles *A. socialis*, from the *Ceratopyge* limestone of Norway.

Observations.—This species has about the same size and general appearance as *Acrotreta seebachi*. It differs from it in the more anterior position of the apex and the strongly defined false area with a median ridge.

FORMATION AND LOCALITY.—**Passage beds** between the Cambrian and the Ordovician: (**310**) *Ceratopyge* limestone (zone 4), at Ottenby, on Oeland Island; and (**309**) *Ceratopyge limestone (zone 4), at Fogelsång, 5 miles (8 km.) east of Lund, Province of Malmöhus;* both [Moberg and Segerberg, 1906, p. 66] in Sweden.

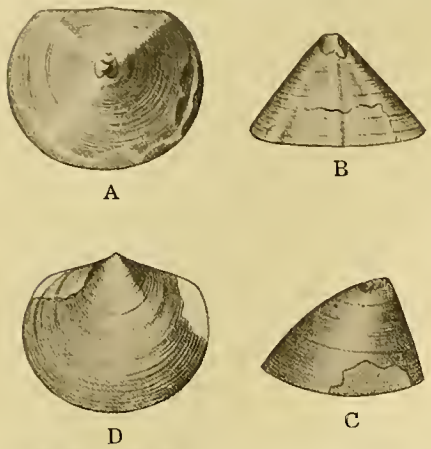

FIGURE 56.—*Acrotreta carinata* Moberg and Segerberg. A, Top view of ventral valve. B, Back view of ventral valve. C, Side view of ventral valve. D, Dorsal valve. All × 8. The ventral is the type.

The specimens represented are from Locality **309**, the *Ceratopyge* limestone at Fogelsång, Province of Malmöhus, Sweden. The figures are copied from Moberg and Segerberg [1906, Pl. III, figs. 5a–e and 6].

ACROTRETA CIRCULARIS Moberg and Segerberg.

Text figures 57A–C.

Acrotreta circularis MOBERG and SEGERBERG, 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), pp. 65–66, Pl. III, figs. 4a–c. (Described in Swedish as a new species; see below for translation. The figures are reproduced in this monograph as figs. 57A–C.)

The original description by Moberg and Segerberg follows:

The apex of the larger shell (ventral valve) is situated midway between the posterior edge and the center, or possibly (the apex itself is not preserved) somewhat closer to the center. On the posterior edge there is a slightly defined triangular area which has a median rounded ridge extending out from the apex. The area as a whole is also somewhat arched, not quite level; at the posterior edge it occupies about one-fifth of the entire circumference of the shell. The height (from the apex to the level of the edge of the shell) is about two-thirds of the breadth. Shell smooth, shiny, with fine concentric growth lines visible even on the area, where, however, they are feebler. On both sides of the apex where the shell, as above mentioned, has been removed, there is found a furrow which on the area is parallel with its nearest side edge, and in the opposite direction runs obliquely toward the side. In the direction from the apex down toward the anterior edge the shell is quite arched. The species differs from *Acrotreta socialis* von Seebach, as known from examples from the *forchhammeri* zone, by its greater size, its distinct keeled area, and the more subcentral position of the apex, which again causes the arch to be less raised.

FIGURE 57.—*Acrotreta circularis* Moberg and Segerberg. A, Top view. B, Posterior view. C, Side view. All × 8.

The specimen represented is from Locality **309**, the *Ceratopyge* limestone at Fogelsång, Province of Malmöhus, Sweden. The figures are copied from Moberg and Segerberg [1906, Pl. III, figs. 4a–c].

Observations.—This shell is nearest to *Acrotreta seebachi* (Pl. LXXVII, figs. 3, 3a). It differs in having the apex farther back from the posterior margin and in the strong median ridge on the false area. It is very close to *Acrotreta carinata* Moberg and Segerberg.

FORMATION AND LOCALITY.—**Passage beds** between the Cambrian and the Ordovician: (**310**) *Ceratopyge* limestone (zone 4), at Ottenby, on Oeland Island; and (**309**) *Ceratopyge limestone (zone 4), at Fogelsång, 5 miles (8 km.) east of Lund, Province of Malmöhus;* both [Moberg and Segerberg, 1906, p. 66] in Sweden.

ACROTRETA CLAYTONI Walcott.

Plate LXXIV, figures 3, 3a–b.

Acrotreta claytoni WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 583. (Described as below as a new species.)

The material representing this species does not give sufficient data for the preparation of a detailed description. The only ventral valve is depressed by compression in the shale; it is transversely broad oval in outline, with the posterior margin nearly straight for a distance of

two-fifths of the diameter of the valve; the false area is fairly well defined by the abrupt incurving of the cardinal slopes; its median furrow is distinctly outlined, and it slopes forward to the apex, which is situated about two-fifths the distance from the posterior margin to the front margin. Pedicle aperture minute and directed upward from the extreme apex of the valve. Dorsal valve gently convex. Surface of shell marked by fine concentric striæ and lines of growth, and very fine irregular, undulating striæ that can be seen only by the aid of a strong lens.

A partial cast of a dorsal valve from the same faunal horizon about 30 miles distant shows a well-defined median ridge and cardinal scars.

Observations.—This species is most nearly related to *Acrotreta primæva* Walcott of the upper *Olenellus* fauna, at Pioche, Nevada. It differs in having a less elevated ventral valve and in the more advanced position of the apex and foraminal aperture. All the specimens known are also smaller than the average of *A. primæva*, the largest being 3 mm. in width and 2.5 mm. in length.

The specific name is derived from Clayton Valley, near the type locality.

FORMATION AND LOCALITY.—**Lower Cambrian**: (41) Limestone in the Pioche formation [Walcott, 1908a, p. 11] on a ridge 2.5 miles (4 km.) northwest of the town of Cherry Creek, White Pine County, Nevada.

(175) *Shales carrying Olenellus on the divide between Clayton and Fish Lake valleys, about 15 miles (24.2 km.) south-southwest of Silver Peak;* (184) shales at the summit of the Silver Peak Range, 10 miles (16.1 km.) southwest of the town of Silver Peak; and (11) shales of No. 3 of the Silver Peak group, Barrel Spring section [Walcott, 1908f, p. 189[a]], 2.5 miles (4 km.) south of Barrel Spring and 0.5 mile (0.8 km.) east of the road, in the extreme southeastern corner of the Silver Peak quadrangle; all in the Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County, Nevada.

ACROTRETA CONCENTRICA Walcott.

Plate LXXVII, figures 1, 1a–b.

Acrotreta concentrica WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 583. (Described as below as a new species.)

Shell small, outline subcircular to transversely broad oval; apex of ventral valve nearly central; false area indicated by a slight flattening of the valve on the posterior side, and a distinctly marked, but very narrow, median furrow. The elevation of the valve is about one-half its diameter. The dorsal valve is slightly convex and its cast is marked by small cardinal scars and a narrow median ridge that extends to the anterior third of the shell. A ventral valve is 1.25 mm. in diameter, and one dorsal valve is 2 mm. in length.

Observations.—This species occurs at about the horizon of *Acrotreta kutorgai* Walcott but is distinguished from that species and all others by the central position of the apex of the ventral valve.

This form owes its specific name to the nearly central position of the apex of the ventral valve.

FORMATION AND LOCALITY.—**Middle Cambrian**: (96x) Limestone 1 mile (1.6 km.) north of Adairsville, 15 miles (24.2 km.) northwest of Cartersville, Cartersville quadrangle (U. S. Geol. Survey), Bartow County, Georgia.

ACROTRETA CONULA Walcott.

Plate LXXV, figures 2, 2a–b.

Acrotreta conula WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 584. (Described as below as a new species.)

Shell small. Ventral valve eccentrically cone-shaped, with a broadly oval transverse aperture. The apex is situated at the posterior third of the distance between the front margin and the posterior edge of the slightly indicated false area. A minute pedicle aperture occurs at the summit of the apex. Dorsal valve convex, with the minute beak at the posterior margin. The cast shows a well-defined median ridge with the central muscle scars well back on the valve.

Surface marked by fine concentric striæ and lines of growth.

This form owes its specific name to the fact that the ventral valve is markedly cone-shaped.

FORMATION AND LOCALITY.—**Upper Cambrian**: (310a) Shales of *Olenus truncatus* zone, Oeland Island, Sweden.

[a] The species mentioned occur at two slightly different localities (11 and 1v), none of the species being common to both localities.

Acrotreta convexa Walcott.

Plate LXVI, figures 6, 6a–c.

Acrotreta convexa Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 584. (Described essentially as below as a new species.)

Shell small, subcircular, valves convex. Ventral valve most elevated at the low apex, which is above the slightly transverse posterior margin. Dorsal valve somewhat less convex than the ventral valve, with its greatest elevation at the posterior third; beak minute, marginal. Length and width of shell 1 mm. Shell substance very thin, but not proportionally thinner than other large forms. Surface marked by fine concentric striæ and lines of growth.

Casts of the interior of the ventral valve show a minute apical callosity and cardinal scars. The cast of the dorsal valve has a long median furrow and minute cardinal scars.

Observations.—This minute shell occurs in the shales and in a fine-grained interbedded sandstone of the Upper Cambrian. It is characterized mainly by the convexity of the dorsal valve and the relatively low ventral valve, characters that point to its descent from a form like *Acrotreta sagittalis.*

The cast of a dorsal valve represented by Plate LXVI, figure 6c, shows a great development of the cardinal muscle scars; this is abnormal or else the valve belongs to another species.

Formation and locality.—**Upper Cambrian:** (**3n**) *Thin-bedded sandstone on Salmon River, Gillis Hill, 13 miles (20.9 km.) south of Marion Bridge;* (**10e**) shales on east branch of Barachois River, 0.5 mile (0.8 km.) north of the cross-road from Boisdale to Upper Leitches Creek; (**10l**) shale on east bank of Barachois River, 6 miles (9.6 km.) from Little Bras d'Or Lake; and (**10i**) shale in high bank on west side of Barachois River, just north of the Boisdale road; all in eastern Cape Breton, Nova Scotia, Canada.

Acrotreta curvata Walcott.

Plate LXVIII, figures 1, 1a–n.

Acrotreta gemma Walcott (in part) [not Billings], 1884, Mon. U. S. Geol. Survey, vol. 8, pp. 17–18, Pl. I, figs. 1d and 1e (not figs. 1a, 1b, 1c, and 1f; see below). (Specimens now referred to *Acrotreta attenuata, A. pyxidicula,* and *A. idahoensis alta* were included with the specimens representing *A. curvata* when this description of *A. gemma* was written, *A. idahoensis alta* being figured (Pl. I, figs. 1a and 1b). The specimens represented by Pl. IX, figs. 9 and 9a, can not be positively located at this time, but it is probable that they should be referred to *A. idahoensis alta.* The specimens represented by Pl. I, figs. 1d and 1e, are redrawn in this monograph, Pl. LXVIII, figs. 1g and 1l, respectively. Fig. 1c represented a specimen of *Acrotreta sabrinæ,* and the specimen represented by fig. 1f is missing.)

Acrotreta gemma Walcott (in part) [not Billings], 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 608, Pl. LXVII, fig. 5b (not figs. 5, 5a, 5c, 5d, and 5e; see below). (Fig. 5b is a copy of Fig. 1d of preceding reference. Specimens now referred to *Acrotreta attenuata, A. pyxidicula, A. idahoensis alta,* and *A. primæva* were included with the specimens representing *A. curvata* in this reference to *A. gemma,* but only the last two were figured; *A. idahoensis alta,* Pl. LXVII, figs. 5 and 5a, and *A. primæva,* Pl. LXVII, figs. 5c, 5d, and 5e.)

Acrotreta gemma Hall and Clarke (in part) [not Billings], 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 102, fig. 55 (not figs. 56 and 57; see below). (Mentioned in the text and fig. 55 copied from Walcott, 1884b, Pl. I, fig. 1d. The specimens represented by figs. 56 and 57 are referred in this monograph to *Acrotreta idahoensis alta.*)

Acrotreta gemma Walcott (in part) [not Billings], 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, p. 449, Pl. LXII, fig. 2e (not figs. 2, 2a–d; see below). (Fig. 2e is a copy of Walcott, 1884b, Pl. I, fig. 1d. Specimens now referred to *Acrotreta attenuata, A. pyxidicula, A. idahoensis alta,* and *A. primæva* were included with the specimens representing *A. curvata* when this description of *A. gemma* was written, but only the last two were figured: *A. idahoensis alta,* Pl. LXII, figs. 2a and 2c, and *A. primæva,* Pl. LXII, figs. 2, 2b, and 2d.)

Acrotreta curvata Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 584. (Characterized essentially as below as a new species.)

This is a clearly defined species and all that is known of it, with the exception of the very fine concentric surface striæ, can be illustrated. It belongs with *Acrotreta idahoensis* Walcott and other species with a broad false area. It differs from described species in the incurved apex of the ventral valve, the strong sinus of the dorsal valve, and the general aspect of the two valves.

This form owes its specific name to the fact that the apex of the ventral valve is strongly incurved.

FORMATION AND LOCALITY.—**Passage beds** between the Upper Cambrian and the Ordovician: (203a) *Limestones at base of Pogonip limestone, in the spur on Hamburg Ridge extending out southwest from Wood Cone, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.*

Upper Cambrian: (12p) About 225 feet (69 m.) above the igneous rocks in the limestones of the Reagan sandstone, at the northwest extremity of the Arbuckle Mountains, about 4 miles (6.4 km.) east of Homer, Carter County, Oklahoma.

ACROTRETA DEFINITA Walcott.

Plate LXIV, figures 2, 2a–g, 3, 3a–b.

Acrotreta definita WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 584–585. (Described essentially as below as a new species.)

For exterior outline, form, and convexity of the valve, the student is referred to the illustrations (Pl. LXIV). It is to be noted that the false pedicle groove is very distinct and also broader than that of *Acrotreta attenuata* Meek. The interior of the ventral valve is beautifully shown by casts. One of these (fig. 2c) shows the strong vascular sinuses, cardinal scars, cast of apical callosity, and, just in front of the latter, two slight tubercles, which may be the cast of depressions corresponding to the foraminal pits of *Acrothele*. The cast of the dorsal valve is also very instructive in showing the area, cardinal scars, median ridge, and central scars.

Observations.—This large fine species differs from its nearest ally, *Acrotreta idahoensis* Walcott, in the false area and the details of the arrangement of the vascular markings and muscle scars of the interior of the valves. The Idaho shells occur in a dark argillaceous shale and were collected by R. S. Spence, of Evanston, Wyoming. The Eureka (Nevada) specimens (Pl. LXIV, figs. 3, 3a–b) are from a shaly limestone.

Acrotreta depressa (Pl. LXVI, figs. 8, 8a–c) occurs at about the same stratigraphic horizon, but it has, when uncompressed, a more elevated and sharper apex.

FORMATION AND LOCALITY.—**Middle Cambrian:** (55) Shaly limestone at the top of the Eldorado limestone [Walcott, 1908f, p. 184], east slope of Prospect Mountain, in New York Canyon, Eureka district [Hague, 1892, Atlas]; and (57) shaly limestone of the Eldorado limestone [Walcott, 1908f, p. 184], at the 700-foot (213.4 m.) level of the Richmond mine, Ruby Hill [Hague, 1892, p. 43, and Pl. I, opposite p. 116]; both in Eureka County, Nevada.

(55c and 163)[a] *Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], about 50 feet (15.2 m.) above the Brigham quartzite and 2,755 feet (839.7 m.) below the Upper Cambrian, in a ravine running up into Danish Flat from Mill Canyon, about 6 miles (9.6 km.) west-southwest of Liberty, and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho.*

(4o) Shale about 375 feet (115 m.) above the unconformable base of the Cambrian, in divide at the head of Jackson Creek (locally known as Sheep Creek), a creek flowing into Jackson Lake about 0.5 mile (0.8 km.) south of its northwestern corner, Teton Mountains, Grand Teton quadrangle (U. S. Geol. Survey), Uinta County, Wyoming.

ACROTRETA DEPRESSA (Walcott).

Plate LXVI, figures 8, 8a–c.

Acrotreta gemma depressa WALCOTT, 1889, Proc. U. S. Nat. Mus. for 1888, vol. 11, pp. 441–442. (Reason given for separation as a new variety.)

Linnarssonia sagittalis WALCOTT, 1889, idem, p. 442. (Mentioned.)

Acrotreta gemma depressa Walcott, MATTHEW, 1902, Trans. Roy. Soc. Canada for 1902, 2d ser., vol. 8, sec. 4, No. 3, p. 109. (Copies Walcott, 1889c, p. 441, and proposes the species *A. depressa*.)

Acrotreta depressa WALCOTT, 1908, Canadian Alpine Journal, vol. 1, No. 2, p. 245, Pl. I, figs. 3, 3a–c. (No text reference. Figs. 3, 3a–c are copied in this monograph, Pl. LXVI, figs. 8c, 8c′, 8a, and 8, respectively.)

A group of depressed ventral valves in an arenaceous argillaceous shale led me [1889c, p. 441] to distinguish the shell as a variety of *Acrotreta gemma* Billings. Material received since 1889, from a black and finer shale, shows an elevated ventral valve much like that of *A. idahoensis alta* Walcott, but at present I am unable to decide that the typical form of

[a] 163 is the type locality.

A. depressa (figs. 8 and 8′) is the same as the elevated ventral valve represented by figure 8c, or that the latter is *A. idahoensis alta;* neither form should be referred to *A. gemma.* *A. definita* (Pl. LXIV, figs. 2, 2a–g) occurs at the same relative stratigraphic horizon as this species and it is about the same size. It differs in having a lower, less elevated, and less pointed apex on the ventral valve.

This form owes its specific name to the fact that its ventral valve is depressed.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**14s**) *About 2,300 feet (701 m.) above the Lower Cambrian and 2,700 feet (823 m.) below the Upper Cambrian in the Ogygopsis zone of the Stephen formation [Walcott, 1908f, p. 210], at the great "fossil bed," on the northwest slope of Mount Stephen;* (**57f**) about 2,200 feet (670.6 m.) above the Lower Cambrian and 2,800 feet (853.4 m.) below the Upper Cambrian in the limestone forming 1 of the Stephen formation [Walcott, 1908f, p. 209], about 0.5 mile (0.8 km.) east of the great "fossil bed" on Mount Stephen; (**58j**) about 1,900 feet (579 m.) above the Lower Cambrian and 3,100 feet (945 m.) below the Upper Cambrian, near the base of the limestone forming 2 of the Stephen formation [Walcott, 1908c, p. 238(7)], on the east side of Mount Stephen about 3,000 feet (914 m.) above the Canadian Pacific Railway track; and (**58r**) about 1,800 feet (548.6 m.) above the Lower Cambrian and 3,200 feet (975.4 m.) below the Upper Cambrian, in the limestones forming 2 of the Stephen formation [Walcott, 1908f, p. 211], in the amphitheater between Mounts Stephen and Dennis; all near Field on the Canadian Pacific Railway, British Columbia, Canada.

ACROTRETA EGGEGRUNDENSIS Wiman.

Plate LXX, figures 2a–d.

Acrotreta eggegrundensis WIMAN, 1902, Bull. Geol. Inst. Univ. Upsala, vol. 6, pt. 1, No. 11, p. 55, Pl. II, figs. 23–29. (Described in German as a new species. The two specimens represented by figs. 29, 27, and 26, and fig. 24 are redrawn in this monograph, Pl. LXX, figs. 2a–c and 2d, respectively.)

Acrotreta eggegrundensis Wiman, WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 299–300. (Characterized as below.)

This species is of a characteristic Middle Cambrian type of *Acrotreta* represented in America by *A. idahoensis* Walcott and *A. kutorgai* Walcott. The surface is marked by unusually strong lines and ridges of growth and the false area is well defined. It is quite distinct from other species of the genus in European formations.

Carl Wiman [1902, p. 51] refers this species to the *Olenellus* sandstone series. The bowlder containing it also carried *Aparchites? anderssoni, Hipponicharion matthewi, Obolus (Westonia) bottnicus, Kutorgina?, Torellella lævigata,* and fragments referred to *Olenellus.* This fauna is essentially Middle Cambrian in its facies, and unless the fragments referred to *Olenellus* are indisputably of that genus, I am inclined to refer the bowlder and its contained fossils to the Middle Cambrian. The fact that *Obolus (Westonia) bottnicus* is nearly identical with *O. (W.) finlandensis* of the Middle Cambrian of Finland also points to the Middle Cambrian age of the fauna.

The specific name is derived from Eggegrund Island, the type locality.

FORMATION AND LOCALITY.—**Middle? Cambrian:** (**311**) *Drift bowlder of coarse-grained, somewhat friable, glauconitic sandstone, No. 3 [Wiman, 1902, p. 57], on Eggegrund Island, about 25 miles (40 km.) northeast of Gefle, Province of Gefleborg;* and (**311a**) drift bowlder of glauconitic sandstone [Wiman, 1902, p. 57], at Norrskedika, a little northwest of Östhammar, Province of Stockholm; both in Sweden.

(**311d**) Drift bowlder of glauconitic sandstone [Wiman, 1902, p. 57], south of Lumparströmmen, Åland Island, Finland, Russia.

ACROTRETA EMMONSI Walcott.

Plate LXV, figure 6.

Acrotreta emmonsi WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 300. (Characterized as below as a new species.)

Only the interiors of the two valves of this species are known. The one illustrated shows the distinct character of the vascular markings and muscle scars. The only shell with which it can be compared is the dorsal valve of *Acrotreta idahoensis* Walcott (Pl. LXV, figs. 1f, 1g). This shell resembles *Obolella,* but its corneous test, cardinal muscle scars, and absence of area of the *Obolella* type prevent a reference to that genus. Fragments of *Olenellus* occur in the layer of limestone from which the specimens were obtained.

The specific name is given in memory of Dr. Ebenezer Emmons, who studied and wrote of the Bald Mountain section.

FORMATION AND LOCALITY.—**Lower Cambrian**: (**35a**) *Shaly limestone on the west slope of the summit of Bald Mountain, 3 miles (4.8 km.) north-northwest of Greenwich, Schuylerville quadrangle (U. S. Geol. Survey);* and (**38a**) limestone 2 miles (3.2 km.) south of North Granville, on the road which turns south from the road running between that village and Truthville, 4 miles (6.4 km.) west-northwest of Granville, Fort Ann quadrangle (U. S. Geol. Survey); both in Washington County, New York.

ACROTRETA GEMMA Billings.

Plate LXVI, figures 1, 1a–b.

Acrotreta gemma BILLINGS, 1865, Geol. Survey Canada, Paleozoic Fossils, vol. 1, pp. 216–217, figs. 201a–f. (Described as below as a new species. The specimens represented by figs. 201b, d, e, and f are redrawn in this monograph, Pl. LXVI, figs. 1, 1a–b, respectively.)

Not *Acrotreta gemma* WALCOTT [1884b, p. 17; 1886b, p. 98; 1891a, p. 608; or 1899, p. 449]. (The specimens referred to *Acrotreta gemma* Billings in the references mentioned have been referred in this monograph to *Acrotreta attenuata, A. curvata, A. idahoensis alta, A. primæva,* and *A. pyxidicula,* which see.)

The original description by Billings follows:

Shell very small, about 1 line in diameter; one valve nearly flat and the other acutely conical. Dorsal valve very gently convex, nearly circular; sides and front margin uniformly rounded; posterior margin very obtusely angulated at the beak, on each side of which a portion of the cardinal edge, equal to one-fourth of the whole width of the shell, is nearly straight; umbo very small; beak apparently depressed to the hinge line and not projecting beyond it; cardinal angles compressed, broadly rounded; a wide, shallow, mesial sinus extends from the front margin about halfway to the beak; elsewhere the valve is gently convex or nearly flat.

Ventral valve acutely conical, with a flat triangular area which is perpendicular to the plane of the lateral margin, its base half the width of the whole shell. In the apex of this valve there is a minute circular aperture, and in one specimen a dark line extends from it down the middle of the area, which appears to represent the foraminal groove of this genus; but in two other specimens of the ventral valve, with the area well preserved, there is no indication of a groove. Surface with very fine concentric striæ.

Width of dorsal valve about 1 line; length about eight-ninths of a line. The height of the ventral valve is about 1 line.

The form of this species is very like that of *A. subconica* Kutorga, but that species is twice the size of this and has the area distinctly grooved.

Observations.—By the courtesy of Prof. J. F. Whiteaves, of the Geological Survey of Canada, I have had the opportunity of studying the type material of this species. Nine specimens of the ventral valve were received, but none of the dorsal valve, as they could not be found. One specimen in a dove-colored limestone appears to belong to a distinct species, which I have named *Acrotreta ovalis.* The remaining specimens show some variation in the angle of slope of the sides of the ventral valve, but four of them are similar to the form illustrated by Billings [1865a, p. 216].

The broad false area, with a scarcely perceptible impression of the path of advance of the pseudodeltidium, is clearly shown in one of the specimens, and faintly in others. Two shells have the apex broken off so as to expose the cast of a minute apical callosity and a small portion of the side of the cast of the main vascular sinus (Pl. LXVI, fig. 1b).

Acrotreta gemma belongs to the *A. subconica* Kutorga group of the genus, having a high ventral valve and a distinct and broad false area. It differs from *A. subconica* in having a less elevated ventral valve and in the apex being in front of the posterior margin instead of extending over it. *Acrotreta gemma* has no strong specific relations with the forms from the Rocky Mountains that I identified with it. *A. attenuata* Meek has a high ventral valve, but the false area is practically absent, a narrow, deep sulcus taking its place. *A. idahoensis alta* Walcott has the elevation and false area, but differs in the details of the area and the outline of the cross section of the ventral valve. It was this form that led me [1884b, p. 17] to consider that *A. gemma* occurred in Nevada, and with the slight knowledge that I then had of the genus and species a wide variation of form was given to *A. gemma.* As far as now known to me, the species is restricted to the type locality.

FORMATION AND LOCALITY.—**Lower Ordovician**: (**314d** [Billings, 1865a, p. 217]) Limestone of Division P of the "Quebec group," 4 miles (6.4 km.) northeast of Portland Creek, Newfoundland.

Acrotreta gemmula Matthew.

Plate LXVI, figures 3, 3a–c; Plate LXXVII, figures 5, 5a–f.

Acrotreta gemmula Matthew, 1894, Trans. Roy. Soc. Canada for 1893, 1st ser., vol. 11, sec. 4, No. 8, pp. 87–88, Pl. XVI, figs. 2a–d. (Described as a new species. The specimens represented by figs. 2a and 2b are redrawn in this monograph, Pl. LXVI, figs. 3a and 3b–c, respectively.)

Acrotreta gemmula Matthew, 1895, Trans. New York Acad. Sci. for 1894–5, vol. 14, p. 126, Pl. V, figs. 5a–d. (Changes stratigraphic range. Copies figures from preceding reference.)

Acrotreta gemmula Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 97, Pl. III, figs. 4a–d. (Mentioned. Figures copied from Matthew, 1894, Pl. XVI, figs. 2c, 2d, 2a, and 2b, respectively.)

Shell small, nearly circular in outline, with the posterior margin slightly straightened. Height of ventral valve above the posterior margin about one-half the length of the valve. Apex slightly incurved over the false area, which varies from nearly vertical to an appreciable forward slope from the margin. False area with rounded lateral margins and a rather strong median groove that terminates in a sulcus at the margin and begins at a minute foraminal aperture just beneath the apex. The position of the pedicle aperture causes it to open almost directly backward. The dorsal valve is moderately and rather uniformly convex. Surface of shell marked by fine, concentric striæ and lines of growth, and toward the outer margin by very fine, undulating, concentric striæ that give the surface, when examined by a strong lens, the fretted appearance shown on a larger scale on *Obolus* (*Westonia*) *ella* (Hall and Whitfield) and a few species of *Acrotreta*. The size of the shell is about that of *Acrotreta convexa* Walcott, 1.5 to 2 mm. in diameter. The shell appears to have been rather thin, as it is indented by the pressure of the fine grains of sand of the matrix, and often bends rather than breaks when compressed. It is built up of very thin layers or lamellæ that in the dorsal valve form a thickened rim.

The cast of the interior of the ventral valve indicates a small but distinctly marked apical callosity penetrated by a rather strong pedicle tube that is directed backward at an angle of about 45°. A trace of the main vascular sinuses is shown at the anterolateral edges of the apical callosity; the casts of the cardinal scars are rather large for so small a shell. The interior of the dorsal valve is marked by a rather strong median ridge, large cardinal scars, and small central scars. One of the strongly marked characters is the strong outer rim.

This is a very clearly defined species and the oldest of the Acadian representatives of the genus, occurring, as it does, just below the "*Protolenus* fauna." The position of the pedicle aperture is similar to that of many species of *Acrothele* and is unusual for the genus, and may be of generic or subgeneric importance.

In the collections made by Loper on Dugald Brook this species occurs with *Obolus* (*Palæobolus*) *bretonensis* (Matthew) in beds beneath *Acrothyra proavia* (Matthew). He collected a fine series of this species at the same horizon from which Matthew obtained the types of his "*Acrotreta papillata*" (see *Acrothyra sera* (Matthew), p. 718). I find that when the outer surface of the shell is well preserved it has a slightly fretted or pitted appearance on specimens from Hanford Brook and also Dugald Brook. Those from Dugald Brook show radiating lines when the thin outer layer of the shell is exfoliated. In some layers of rock all the shells are finely pitted, evidently by the fine grains of quartz sand in the matrix being pressed against the shell; in other layers the shells are identical in surface markings and form with those of *A. gemmula* from Hanford Brook.

The interiors of the dorsal valve are not sufficiently well preserved for comparison, but in the ventral valve they are essentially the same. In each locality there is considerable variation in the form and size of the apical callosity.

Formation and locality.—**Middle Cambrian**: (**301a** [*Matthew, 1894, p. 88*]) *Fine-grained sandstones below the Protolenus-bearing shales and sandstones in Division 1b3 of Matthew on Hanford Brook;* and (**301** [Matthew, 1895a, p. 126]) sandstones of Division 1b2 of the "*Protolenus* zone" of Matthew on Hanford Brook; both in St. John County, New Brunswick.

(**10p**) Sandstone just below the waterfall in Division E2b of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River; and (**10p″**) sandstone on the small brook on the hill between the bridge over Indian River and McPhees Brook; both in eastern Cape Breton, Nova Scotia, Canada.

Acrotreta gracia Walcott

Plate LXVI, figures 5, 5a–d.

Acrotreta gracia Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 586–587. (Described and discussed essentially as below as a new species.)

Shell small, slightly transverse; apex of ventral valve about one-third the length of the shell from the posterior margin; height about two-thirds the length of the shell; false area defined by the sharp rounding of the cardinal slopes and the transverse posterior margin, which is indented by the strong, broad, median groove extending from the margin to the apex, where it almost comes in contact with the minute apical pedicle opening. Dorsal valve moderately convex with a nearly straight or gently curved posterior margin; beak minute, marginal. Surface of shell marked by fine concentric striæ and lines of growth. Shell strong and built up of thin layers or lamellæ that over the central and anterior portions are more or less oblique to the outer surface layer.

The cast of the ventral valve indicates a small but very clearly marked apical callosity; rather small cardinal scars and main vascular sinuses. The false area is narrow and broken midway by a rather wide, slightly arching false deltidium. The cast of the interior of the dorsal valve shows a broad, low, median ridge extending to about the anterior third of the length of the valve, large cardinal muscle scars, and small main vascular sinuses that arch inward after passing the central scars, and then outward.

Observations.—This species is distinguished by the strong shell, broad median ridge of the dorsal valve, and deep median groove of the false area of the ventral valve. The light color of the shell may be owing to the character of the limestone in which it is preserved, or it may be that it is a little more calcareous than other species of the genus.

The *Acrotreta* which Matthew [1897b, p. 169] describes and illustrates from the Hastings Cove locality (''*Linnarssonia belti magna*'') is characterized by a narrow median ridge in the dorsal valve and other characters not present in *A. gracia*. In the *Paradoxides* zone on Hanford Brook I found numerous examples of a species of *Acrotreta* that appears to be identical with the form described by Matthew [1897b, p. 169] and have referred it as a variety (*magna*) of *Acrotreta sagittalis* (Salter) (p. 706).

Formation and locality.—**Middle Cambrian:** (2s) Limestone in upper part of *Paradoxides* zone, Hastings Cove [Matthew, 1898b, p. 38], on Kennebecasis Bay, 0.5 mile (0.8 km.) northeast of Torryburn, on the Intercolonial Railway, northeast of St. John, St. John County, New Brunswick.

Acrotreta idahoensis Walcott.

Plate LXV, figures 1, 1a–i; Plate LXVIII, figures 2, 2a–g.

Acrotreta attenuata Meek (in part), 1873, Sixth Ann. Rept. U. S. Geol. and Geog. Survey Terr. for 1872, p. 463, footnote. (Among the specimens which Meek listed as *A. subconica* and for which he proposed the name *A. attenuata* in a footnote are specimens which are now referred to *A. idahoensis*. See also *A. attenuata* and *A. attenuata* var.)

Not *Acrotreta subconica* Kutorga, 1848, Verhandl. Russ.-kais. min. Gesell. St. Petersburg for 1847, No. 12, p. 275. (Referred in this monograph to *Acrotreta subconica*.)

Acrotreta idahoensis Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 587. (Described essentially as below as a new species.)

The general outline, form, and convexity of the two valves are so fully shown by the illustrations that detailed descriptions will not be given. The material for illustrating the interior of the ventral valve is limited, but one cast shows the position of the base of the cast of the foraminal tube, and the large, main vascular sinuses (Pl. LXV, fig. 1d). An interior of a dorsal valve and the accompanying cast (Pl. LXV, figs. 1f, 1g) present characters rarely seen in this genus. The vascular canals arch out beyond the central muscle scars, and then bend in toward the median ridge, and again obliquely outward to form the outer limit of a smooth, polished, lanceolate-shaped surface that extends obliquely outward from the median ridge. The line that extends from in front of the cardinal scars forward, subparallel to the margin of the shell, and then bends abruptly in and forward is apparently the outer boundary of a very broad,

shallow, vascular sinus. Something of this same character occurs in the dorsal valve of *Obolus* (*Lingulobolus*) *spissus* (Billings) (Pl. XVI, figs. 2, 2d). The cardinal scars are small and situated close to the narrow area. Another cast of the interior (fig. 1e) shows the central scars distinctly; also the presence of a thickening of the shell in the vicinity of the cardinal scars. The median ridge is smaller and shorter than in Plate LXV, figure 1g.

Observations.—The external characters of this species suggest *Acrotreta curvata* Walcott, but the elevation and curvature of the ventral valve are not the same and the interior of the dorsal valve is very distinct in its specific characters. There are no interiors of the form from the Black Hills, but the external characters appear to be the same. These include the broad false area, with its slightly marked groove, the position of the apex, and the curvature of the false area.

Acrotreta idahoensis has been found in the Dunderberg shale of the Eureka district, Nevada, and it extends up also to the base of the Pogonip limestone. The horizon is higher than that of the type specimen, but the shells from the higher and lower horizons appear to be identical.

Formation and locality.—**Lower Ordovician**: (**201a**) Pogonip limestone, east slope of the ridge east of Hamburg Ridge; and (**202**) Pogonip limestone on the summit of the ridge directly southeast of the Jackson mine, northwest of Shadow Canyon; both in the Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

Upper Cambrian: (**61**) Limestone in the Dunderberg shale [Walcott, 1908f, p. 184], a little south of the Hamburg mine, Eureka district [Hague, 1892, Atlas], Eureka County; and (**313**) limestone 0.75 mile (1.2 km.) east-northeast of McGill post office, White Pine County; both in Nevada.

(**15d**) Thin-bedded blue limestone near Cave Spring, on the east side of the Fish Spring Range, about 4 miles (6.4 km.) south of the J. J. Thomas ranch, Juab County; and (**30h**) about 350 feet (106.7 m.) above the Middle Cambrian and 2,950 feet (899.2 m.) below the top of the Upper Cambrian, near the base of the arenaceous limestones forming 2a of the Orr formation [Walcott, 1908f, p. 177], on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County; both in Utah.

(**5c** and **54t**) *Limestones of the St. Charles formation* [*Walcott, 1908a, p. 6*], *about 250 feet (76 m.) above the Middle Cambrian;* and (**54u**) limestones of the St. Charles formation about 100 feet (30.2 m.) above the Middle Cambrian; both on the north side of Twomile Canyon near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

(**56g**) Limestone of the St. Charles formation [Walcott, 1908a, p. 6], in the valley of the stream which flows into Mill Canyon from the west, about 6 miles (9.6 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho.

Middle Cambrian: (**88a**) Limestone about 100 feet (30.5 m.) above the quartzitic sandstone at the base of the Cambrian, in the northern suburbs of Deadwood; and (**165**) limestone on the east side of the valley, in railroad cut about 1 mile (1.6 km.) below the main part of Deadwood; both in the Black Hills, South Dakota.

(**302a**) Limestones at several places on the south side of the Gallatin Valley, Gallatin County, Montana.

(**302b**) Limestones near Crowfoot Ridge, Gallatin quadrangle (U. S. Geol. Survey), Yellowstone National Park, Wyoming.

(**59g**) Limestones immediately overlying the Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], in a saddle north of the creek which flows into Mill Canyon from the west, about 5 miles (8 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Liberty, Bear Lake County, Idaho.

(**11o**) About 2,750 feet (838.2 m.) above the Lower Cambrian and 1,650 feet (502.9 m.) below the Upper Cambrian, at the base of 1a of the Marjum limestone [Walcott, 1908f, p. 179], about 4 miles (6.4 km.) southeast of Antelope Springs, in the spur at the junction of the Deseret and Swasey Spring roads [Walcott, 1908f, Pl. XIII], House Range, Millard County, Utah.

Acrotreta cf. idahoensis.

This species is represented by a single specimen of a somewhat imperfect ventral valve. It is larger than the average shells of *Acrotreta idahoensis* Walcott, and appears to have had a more incurved apex. The exterior layer is also duller and less distinctly striated than most specimens of the latter species. The shell is built up of numerous thin layers or lamellæ, more or less oblique to the outer surface; the lamellæ are marked by numerous fine radiating striæ and a few concentric striæ. The general impression given by the shell is that it is an old shell which has thickened by growth and become more robust and incurved than is usual in the species with which it is compared.

Formation and locality.—**Middle Cambrian**: (**7j**) Limestones at the north end of the Quinn Canyon Range, 1 mile (1.6 km.) northwest of the Italian Ranch foothills, Nye County, Nevada.

ACROTRETA IDAHOENSIS ALTA Walcott.

Plate LXV, figures 4, 4a–b.

Acrotreta gemma WALCOTT (in part) [not BILLINGS], 1884, Mon. U. S. Geol. Survey, vol. 8, pp. 17–18, Pl. I, figs. 1a and 1b (not figs. 1c–f; see below), and (?) Pl. IX, figs. 9 and 9a (see also below). (Specimens now referred to *Acrotreta attenuata*, *A. pyxidicula*, and *A. curvata* were included with the specimens representing *A. idahoensis alta* when this description of *A. gemma* was written, *A. curvata* being figured, Pl. I, figs. 1d and 1e. The specimen represented by Pl. I, fig. 1a, is redrawn in this monograph, Pl. LXV, fig. 4a. Fig. 1c represented a specimen of *Acrotreta sabrinæ;* the specimens represented by figs. 1f and 9 and 9a are missing.)

Acrotreta gemma WALCOTT (in part) [not BILLINGS], 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 608, Pl. LXVII, figs. 5 and 5a (not figs. 5b–e; see below). (Figs. 5 and 5a are copied from figs. 1a and 1b of preceding reference. Specimens now referred to *Acrotreta attenuata*, *A. pyxidicula*, *A. curvata*, and *A. primæva* were included with the specimens representing *A. idahoensis alta* in this reference to *A. gemma*, but only the last two were figured: *A. curvata*, Pl. LXVII, fig. 5b, and *A. primæva*, Pl. LXVII, figs. 5c, 5d, and 5e.)

Acrotreta gemma Walcott, HALL and CLARKE (in part) [not BILLINGS], 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 102, figs. 56 and 57 (not fig. 55). (Mentioned in the text, and figures copied from Walcott, 1884b, Pl. I, figs. 1a and 1b. The specimen represented by fig. 55 is referred in this monograph to *Acrotreta curvata*.)

Acrotreta gemma WALCOTT (in part) [not BILLINGS], 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, p. 449, Pl. LXII, figs. 2a and 2c (not figs. 2, 2b, 2d, and 2e; see below). (Figs. 2a and 2c are copied from Walcott, 1884b, Pl. I, figs. 1a and 1b, respectively. Specimens now referred to *Acrotreta attenuata*, *A. pyxidicula*, *A. curvata*, and *A. primæva* were included with the specimens representing *A. idahoensis alta* when this description of *A. gemma* was written, but only the last two were figured: *A. curvata*, Pl. LXII, figs. 2c, and *A. primæva*, Pl. LXII, figs. 2, 2b, and 2d.)

Acrotreta idahoensis alta WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 588. (Characterized essentially as below as a new variety.)

This is one of the forms that I included with *Acrotreta gemma* Billings in the report on the Paleontology of the Eureka district, Nevada [1884b, p. 17]. It has the broad false area of *A. idahoensis* Walcott, but the ventral valve is more elevated and the apex does not overhang the false area. From *A. attenuata* Meek it differs in having a broad false area.

A form indistinguishable from *Acrotreta idahoensis alta* occurs in the Dunderberg shale of the Eureka district section of Nevada. The horizon is higher than that of the type specimen, but there appears to be no way of distinguishing between the type and the Dunderberg shale specimens.

A similar but smaller form extends up through from the Dunderberg shale into the arenaceous and calcareous shales at the base of the Pogonip limestone, where fossils of the Ordovician fauna occur.

This form owes its varietal name to its high ventral valve.

FORMATION AND LOCALITY.—**Lower Ordovician:** (**63**) At base of Pogonip limestone, northeast of Adams Hill, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

Passage beds between the Upper Cambrian and the Ordovician: (**201**) Arenaceous Pogonip limestone on east slope of ridge east of Hamburg Ridge; and (**206a**) sandy limestone on Hoosac Mountain; both in the Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

Upper Cambrian: (**61**) Limestone in the Dunderberg shale [Walcott, 1908f, p. 184], a little south of the Hamburg mine; and (**65**) limestone on the east side of Sierra Canyon, opposite Pinnacle Peak; both in the Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

(**54f**) 150 feet (45.7 m.) above the Middle Cambrian and 1,075 feet (327.7 m.) below the top of the Upper Cambrian in light-gray sandstone forming No. 4 of the St. Charles formation [Walcott, 1908f, p. 193], in Blacksmith Fork Canyon about 10 miles (16.1 km.) east of Hyrum, Cache County; (**34q**) shales about 3,800 feet (1,158.2 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], in Wasatch Canyon, east of Lakeview ranch, about 5 miles (8 km.) north of Brigham, Boxelder County; and (**15d**) thin-bedded blue limestone near Cave Spring on the east side of the Fish Spring Range, about 4 miles (6.4 km.) south of the J. J. Thomas ranch, Juab County; all in Utah.

Middle? Cambrian: (**33n**) Limestone pebbles, west front of the Pavant Mountains, at the mouth of Crow Creek, about 4 miles (6.4 km.) east of Fillmore, Millard County, Utah.

Middle Cambrian: (**58**) *Shaly limestone in upper beds of Secret Canyon shale, east side of New York and Secret canyons, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.*

(**7i**) Limestone just west of the summit on the road east of Schellbourne; and (**313b**) limestones 3 miles (4.8 km.) north-northeast of Schellbourne; both in the Schell Creek Range, White Pine County, Nevada.

(**302w**) Limestone at Madison Mountain, Montana.

Acrotreta idahoensis sulcata Walcott.

Plate LXV, figure 5.

Acrotreta idahoensis sulcata Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 588. (Characterized as below as a new variety.)

This strongly marked ventral valve is associated with the variety *alta*, but in its rounded posterior side and strong median groove it is quite distinct. The apex is broken off so as to show the cast of a small apical callosity and the base of a minute foraminal tube.

This form owes its varietal name to the fact that it possesses a sulcate ventral valve.

Formation and locality.—**Upper Cambrian**: (**30h**) About 350 feet (106.7 m.) above the Middle Cambrian and 2,950 (899.2 m.) below the top of the Upper Cambrian, near the base of the arenaceous limestones forming 2a of the Orr formation [Walcott, 1908f, p. 177], on Orr Ridge, about 5 miles (8 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah.

(**54t**) Limestone of the St. Charles formation [Walcott, 1908a, p. 6], about 250 feet (76 m.) above the Middle Cambrian, on the north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

Middle Cambrian: (**54s**) Dark blue-gray Langston limestone [Walcott, 1908f, p. 198], just above the Cambrian quartzitic sandstones, north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County; (**55e**) Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], about 50 feet (15.2 m.) above the Brigham quartzite and 2,755 feet (839.7 m.) below the Upper Cambrian, in a ravine running up into Danish Flat from Mill Canyon, about 6 miles (9.6 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County; and (**322a**) *Langston limestone near Paris, Bear Lake County*; all in Idaho.

Acrotreta inchoans (Barrande).

Plate XV, figures 7, 7a.

Lingula inchoans Barrande, 1868, Faune silurienne des environs de Hof, en Bavière, p. 102, figs. 74 and 75. (Described in French as a new species; see below for translation. Figs. 74 and 75 are reproduced in this monograph, Pl. XV, figs. 7 and 7a, respectively.)

Lingula inchoans Barrande, 1868, Neues Jahrb. für Mineralogie for 1868, p. 692, unnumbered plate, figs. 74 and 75. (Copy of preceding reference.)

Acrothele inchoans (Barrande), Pompeckj, 1896, Tremadoc Fossilien bei Hof, p. 3. (Discussed in German.)

Acrothele inchoans (Barrande), Matthew, 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 5, No. 20, p. 404. (Mentioned.)

Acrothele inchoans (Barrande), Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 103. (Copy of preceding reference.)

The original description by Barrande follows:

Under this name we unite several very small shells, rounded in appearance, but more or less elongated, which, however, might represent merely the youthful form of another species. These very flat shells show one or two concentric grooves at the external contour. The one which is represented in figure 74 [Pl. XV, fig. 7, of this work] has, moreover, in the middle a faint longitudinal groove which extends nearly throughout its length.

Dimensions: Length, 2 mm.; breadth, 3.2 mm. on the specimen in figure 74 [Pl. XV, fig. 7, of this work].

Observations.—Pompeckj wrote me that he had concluded that this species was an *Acrotreta* and not a *Lingula*. The illustrations and descriptions of Barrande suggest that the specimens represent the compressed dorsal valves of *Acrotreta*.

Matthew [1902a, p. 404] places this species under *Acrothele*, but with only the figure given by Barrande I prefer to accept Pompeckj's provisional reference to *Acrotreta*.

Formation and locality.—**Passage beds** between the Upper Cambrian and the Ordovician: (**303e** [*Barrande, 1868a, p. 102*]) *Dark argillaceous shale in the suburbs of Hof;* and (**303f** [Pompeckj, 1896a, pp. 7 and 8]) railway cut near Schellenberg, a little distance back of the railway station at Neuhof, near Hof; both in Bavaria, Germany.

Acrotreta inflata (Matthew).

Plate LXXVI, figures 1, 1a–k, 2, 2a.

Lingulella? inflata Matthew, 1886, Trans. Roy. Soc. Canada for 1885, 1st ser., vol. 3, sec. 4, No. 4, p. 33, Pl. V, figs. 7 and 7a. (Discussed as a new species. The specimen represented by figs. 7 and 7a is redrawn in this monograph, Pl. LXXVI, fig. 2.)

Lingulella? inflata Matthew, 1895, Trans. New York Acad. Sci. for 1894–95, vol. 14, p. 127, Pl. V, figs. 3a–b. (Mentioned. Figures copied from preceding reference.)

Lingulella? inflata ovalis MATTHEW, 1895, Trans. New York Acad. Sci. for 1894–95, vol. 14, p. 127, Pl. V, figs. 4a–c. (Described and discussed as a new variety. The specimen represeuted by figs. 4a–c is redrawn in this monograph, Pl. LXXVI, fig. 2a.)

Lingulella? inflata MATTHEW, 1898, Trans. Roy. Soc. Canada for 1898, 2d ser., vol. 4, sec. 4, No. 2, p. 128. (Mentioned.)

Acrothyra? inflata MATTHEW, 1901, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 4, No. 19, p. 304. (Merely suggests change in generic reference.)

Lingulella (Acrothyra?) inflata MATTHEW, 1902, idem, vol. 4, pt. 5, No. 20, p. 390. (Mentioned.)

Acrotreta inflata (Matthew), WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 588–589. (Described essentially as below.)

Shell subcircular to transversely broad oval. Ventral valve subconical, with the apex directed backward and usually on a line with the posterior margin, or extending beyond it (Pl. LXXVI, figs. 1′ and 1a′), but it may be anterior to it (Pl. LXXVI, figs. 1b′ and 1d′); false area slightly defined by the abrupt curvature of the cardinal slopes, median line depressed, narrow, the two sides of the false area incurving to form it (Pl. LXXVI, fig. 1g); pedicle aperture longitudinally oval and slightly truncating the apex. Dorsal valve gently convex, with a minute marginal beak. Surface of shell marked by concentric striæ and growth lines, and fine, irregular, wavy striæ that inosculate more or less, giving the surface a fretted appearance under a strong lens. The inner surface is marked by concentric lines and rather strong radiating lines. The shell is built up of a thin outer ornamented surface and several thin inner layers or lamellæ. The average length of the ventral valve is 4 mm. and the width 3 to 3.5 mm. The dorsal valves are usually wider than long. Casts of the interior of the ventral valve show strong cardinal scars, a strong apical callosity, and rather weakly developed main vascular sinuses. The apical callosity varies in size and in form from elongate oval (Pl. LXXVI, fig. 1b) to subcircular (fig. 1f). The cast of the interior of the dorsal valve shows large cardinal muscle scars, and a broad, short median ridge posteriorly that extends beyond the center of the valve.

Observations.—This species appears to be a true *Acrotreta* with the apical callosity elongated by the elongation of the ventral valve. The dorsal valve is more convex than in most species of *Acrotreta*, which gives a stronger relief to the ridges on the cast between the cardinal scars and the median ridge. The posterior view (Pl. LXXVI, fig. 1k′) should be compared with the same view of the dorsal valve of *Acrotreta sagittalis* (Salter) and its varieties (Pl. LXXI, figs. 1l′, 1m′, and 3g″; and Pl. LXXII, figs. 1e′ and 1f′). The fretted surface is of the same type as that of several other species of the genus.

Matthew had very little material when he described the species [1886, p. 33]; subsequently [1895a, p. 127] he created the variety *ovalis* from a more elongated ventral valve. In the collection made for the United States National Museum by Loper, there are a number of ventral and dorsal valves. The range of variation in outline appears to cover the variety *ovalis*. Some are more transverse than the original type of the species and others nearly as elongate as the variety *ovalis*. I have therefore considered the variety as within the original species. Some of the shells show elongation and others are broadened by distortion.

Matthew [1895a, p. 127] called attention to the resemblance of this species to *Linnarssonia* and *Acrotreta*, and when describing the genus *Acrothyra* suggested [1901b, p. 304] that it might belong to that genus. It appears, however, to be a true *Acrotreta*. A series of specimens, supplemented by the types and a number of ventral valves received from Doctor Matthew which he had [1895a, p. 126] provisionally identified as "*Acrotreta gemma* Billings?" show a rather remarkable variation in outline and position of the apex of the ventral valve. This is illustrated by the figures on Plate LXXVI, also by a number of specimens not illustrated. The narrow forms, var. *ovalis* Matthew, have the apex extended beyond the posterior margin, and in the broad forms the apex is above or in advance of the posterior margin, but if the shells are compressed vertically the apex may be pushed out over the false area whether the shell be narrow or broad. I think that in the normal form the false area is vertical or slightly inclined backward.

FORMATION AND LOCALITY.—**Middle Cambrian**: (2f and 2g)[a] Sandstones of Division 1bl of Matthew's [1895a, p. 108] *Protolenus* zone, Hanford Brook, St. John County, New Brunswick, Canada.

[a] The specimens in the United States National Museum collections to which these numbers are assigned were collected at the type locality but later than the type specimens.

Acrotreta kutorgai Walcott.

Text figure 58; Plate LXV, figures 3, 3a–e, 3g–k.

Acrotreta kutorgai Walcott (in part), 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 589–590. (Described as a new species, but owing to a different interpretation of the structural characters of the ventral valve the description differs from the one given below. Specimens now referred to *Acrotreta rudis* were included with true representatives of *A. kutorgai* in this description.)

The external characters of the ventral valve are clearly exhibited (Pl. LXV) by figures 3, 3a, and 3d, and what is known of the interior by figures 3b and 3c. Figure 3g is that of a most interesting specimen, as it clearly shows the cast of the cardinal area of the dorsal valve adjusted against the false area and pseudodeltidium of the ventral valve. In 1902 (p. 589) I considered this cast of the cardinal area of the dorsal valve to be the true area and pseudodeltidium of the ventral valve, and figure 3g was drawn to bring out this interpretation.

Figure 58 represents a view into the interior of the cast, showing the cast of the false area and pseudodeltidium of the ventral valve, as well as the cast of the cardinal area of the dorsal valve. The cardinal area of the dorsal valve is well defined in the casts represented by Plate LXV, figures 3h–j. The median ridge of the dorsal valve is as long proportionally as that of *A. bisecta*, and like it varies in length and size in different shells.

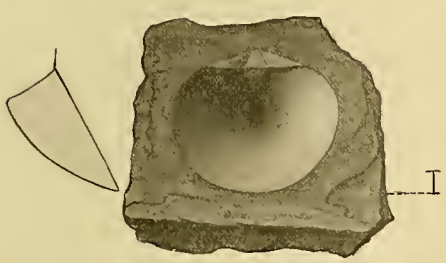

Figure 58.—*Acrotreta kutorgai* Walcott. View into interior, the specimen being tipped, as shown in the side outline. A vertical view of the same specimen is shown in Plate LXV, figure 3g.

The specimen represented is from Locality 90x, in Coosa Valley, Alabama (U. S. Nat. Mus. Cat. No. 35277a).

The outer surface is marked by fine concentric striæ and lines of growth.

Observations.—This pretty species occurs attached to the surface of siliceous nodules in association with *Olenoides curticei*, *Crepicephalus texanus*, *Acrothele bellula* Walcott, and casts of Medusæ. The outline of the convexity of the valves and the posterior view of the ventral valve is most like that of *A. attenuata* Meek, but the interior markings are quite unlike.

The specific name was given in honor of Kutorga.

Formation and locality.—**Upper Cambrian:** (**361**) Shaly limestone in suburb of Attalla, Etowah County, Alabama.

(**107o** and **107u**) Limestones and shales at the base of the Knox dolomite, west of the top of Copper Ridge, near the Southern Railway cut, about 10 miles (16.1 km.) northwest of Knoxville [Keith, 1896b, areal geology sheet], Knox County, Tennessee.

Middle Cambrian: (**90b**) Conasauga limestone in cut on Louisville and Nashville Railroad, near Woodstock, Bibb County; (**90**) Conasanga ("Coosa") shale on Edwards farm, near Craigs Mountain, about 10 miles (16.1 km.) southeast of Center, Cherokee County; (**140**) limestone interbedded in shales near Chepultepec, Blount County; (**90x**) *in and attached to the outer surface of siliceous nodules in the Conasauga ("Coosa") shale, Coosa Valley, Cherokee County;* (**137**) shales on the southeast side of the northeast end of the Cane Creek Mountains, 3 miles (4.8 km.) south of Gadsden, Etowah County; and (**139a**) limestones on road near Wades Gap, near Chepultepec, Blount Connty; all in Alabama.

Specimens that are somewhat doubtfully referred to this species occur at the following localities:

Middle Cambrian: (**142**) Shales just above the *Olenellus* zone, near the railroad, 4.5 miles (7.2 km.) north of Montevallo, Shelby County, Alabama.

(**18**) Limestone 1 mile (1.6 km.) east of Gap Creek, 13 miles (20.8 km.) S. 75° E. of Knoxville, Knox County, Tennessee.

Acrotreta lisani Walcott.

Plate LXVIII, figures 3, 3a–c.

Acrotreta liani Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 300. (Described and discussed as below as a new species. Li San's name was at that time believed to be correctly written as Lian, hence the form of the specific name.)

Shell small, about 1.5 mm. in diameter; outline of aperture subcircular, the posterior side being slightly transverse. Ventral valve conical, with the apex a little in advance of

the posterior margin; false area indefinite, except for a rather strong, shallow furrow that extends from the apex to the margin. The elevation of the valve is about two-thirds its diameter at its aperture. Dorsal valve slightly convex, apex marginal. Surface of shell marked by fine, concentric striæ and lines of growth that on the dorsal valve tend to form low ridges toward the outer margins.

Observations.—This species is the representative of the American *Acrotreta idahoensis sulcata* Walcott. It has the same type of false area, and the ventral valve is of average height.

The specific name is given in recognition of Li San, Mr. Willis's faithful Chinese interpreter.

Formation and locality.—**Middle Cambrian**: (**C22**) Changhia limestone in upper oolitic portion [Blackwelder, 1907a, pp. 22 and 33 (part of last list of fossils)], at Changhia, Shantung, China.

Acrotreta marjumensis Walcott.

Plate LXXVIII, figures 2, 2a–d.

Acrotreta marjumensis Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 94–95, Pl. IX, figs. 2 and 2a. (Described and discussed as below as a new species. Figs. 2 and 2a are copied in this monograph, Pl. LXXVIII, figs. 2 and 2c, respectively.)

The general form of this species is much like that of *Acrotreta idahoensis* Walcott. The ventral valve differs in having a more strongly marked and broader false area and in the greater curvature of the apex over the false area. It is also less elevated, or convex, in proportion to the size of the shell. It may also be compared with *A. neboensis* Walcott, from which it differs in being less elevated and in not having a well-indicated false pedicle furrow. The dorsal valve is moderately convex and differs little from the dorsal valve of *A. idahoensis* and *A. neboensis*.

The interior of the dorsal valve shows a narrow median ridge that, at the center and toward the front of the shell, rises as a sharp, rather high, and very narrow ridge. This ridge starts posteriorly from a subtriangular, somewhat elevated area which has a longitudinal furrow crossing it. The cardinal and central muscle scars are very clearly defined; in some cases the central scars are slightly depressed, and in other shells elevated above the general surface of the interior of the shell.

The specific name is derived from Marjum Pass, near the type locality.

Formation and locality.—**Upper Cambrian**: (**33d**) Thin-bedded blue limestone at the base of the first high point southwest of the J. J. Thomas ranch, on the east side of the Fish Spring Range, Juab County, Utah.

Middle Cambrian: (**11n**) *About 3,000 feet (914.4 m.) above the Lower Cambrian and 1,400 feet (426.7 m.) below the Upper Cambrian, in the upper part of the limestone forming 1a of the Marjum limestone* [*Walcott, 1908f, p. 179*], *in the long cliff 2 miles (3.2 km.) southeast of Marjum Pass, House Range* [*Walcott, 1908f, Pls. XIII and XV*], *Millard County, Utah.*

Acrotreta microscopica (Shumard).

Plate LXVII, figures 1, 1a–h, 1o, 2, 2a–d.

Discina microscopica Shumard, 1861, Am. Jour. Sci., 2d ser., vol. 32, p. 221. (Described as a new species.)

The external outline, form, and convexity of the two valves are so fully illustrated by the figures that I will only call attention to the variation in the outline of the elevation of the ventral valve. In Plate LXVII, figure 1d″, the false area slopes backward instead of forward as in other specimens. The lines of growth show that the growth of the anterior portion of the shell was much more rapid than on the posterior face, thus causing the apex to tip back toward the area, a feature not observed in the other specimens illustrated. The concentric surface striæ are sharp, but very fine. The only interior of a ventral valve found is represented by figures 1o, 1o′, and 1o″.

The typical forms from Texas are represented by Plate LXVII, figures 1, 1a–h, and 1o, and what appears to be an identical form from Nevada by figures 2, 2a–d. The latter form shows about the same range of variation in outline and position of the apex of the ventral valve as the typical forms from Texas. This species belongs to the group of forms with a wide false area. It differs from *A. idahoensis* Walcott and *A. curvata* Walcott in the form of the ventral valve.

Acrotreta microscopica has remained without illustration for many years. I made a large collection in Burnet County, Texas, in 1884, which was increased by Cooper Curtice in 1890. We found the little shell in great numbers associated with characteristic Upper Cambrian fossils. In the Eureka district, Nevada, there is a small species of *Acrotreta*, which, so far as can be determined from the material available for study, is identical with the *A. microscopica* as it occurs in the Upper Cambrian limestones of Texas. It has essentially the same range of variation in the form of the ventral valve, and the dorsal valves also appear to be identical. (Compare figs. 1 and 2a (the latter has been broadened by pressure); figs. 1d′ and 2′; and the side outlines 1a and 2c; and 1b″ and 2b.) The ventral valves have the same outline and convexity. The outlines of the convexity of figures 1e–g should be more nearly as in figures 1h and 2d and not concavo-convex as shown on the plate.

FORMATION AND LOCALITY.—**Upper Cambrian:** (67) Sandstone on Tatur Hill, 7 miles (11.2 km.) northwest of Burnet, Burnet County; and (70e) *limestone near Morgans Creek, Burnet County;* (69) limestone near Honey Creek, Burnet County; (71) limestone in Cold Creek Canyon, Burnet County; (68 and 68e) limestone in Packsaddle Mountain, Llano County; (14b) limestone on Cold Creek at north end of gorge opposite the north end of Sponge Mountain, 2 miles (3.2 km.) south of the San Saba County line, in Llano County; (14g) limestone 1 mile (1.6 km.) west of Cherokee, San Saba County; and (14e) limestone in Bartlett Hollow, 2 miles (3.2 km.) southeast of the mouth of Falls Creek, Burnet quadrangle (U. S. Geol. Survey), Lampasas County; all in Texas.

(12p) About 225 feet (69 m.) above the igneous rocks, in the limestones of the Reagan sandstone, at the northwest extremity of the Arbuckle Mountains, about 4 miles (6.4 km.) east of Homer, Carter County; (12n) limestones of the Reagan sandstone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 240 feet (73 m.) above the porphyry contact and 40 feet (12 m.) below the Arbuckle limestone), NW. ¼ sec. 1, T. 2 S., R. 1 E., Ardmore quadrangle, Carter County; (12k) limestones of the Reagan sandstone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 225 feet (69 m.) above the porphyry contact and 55 feet (17 m.) below the Arbuckle limestone), on the west side of Honey Creek, near the southeast corner of sec. 35, T. 1 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County; and (9r and 9t) about 45 feet (14 m.) and 170 feet (52 m.), respectively, above the porphyry contact in the limestones of the Reagan sandstone, SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W., 15 miles (24.2 km.) northwest of Fort Sill, Comanche County; all in Oklahoma.

Upper? Cambrian: (8o) Limestone on the slope of the ridge where the range swings around to the northwest, 2 miles (3.2 km.) north of Aurum, Schell Creek Range, White Pine County, Nevada.

Middle Cambrian: (58) Shaly limestones in upper beds of Secret Canyon shale, east side of New York and Secret canyons, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

ACROTRETA MICROSCOPICA MISSOURIENSIS Walcott.

Plate LXVII, figures 4, 4a–b.

Acrotreta microscopica missouriensis WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 590. (Described as below as a new variety.)

The shell is uniformly larger and the vertical median line of the false area more depressed, incurved, and distinct than those of *Acrotreta microscopica* (Shumard) and the variety *tetonensis* Walcott. Some of the specimens of the ventral valves beautifully illustrate the effects of compression. One shell (Pl. LXVII, figs. 4′ and 4″) is like that of *Acrotreta attenuata* Meek and the other (Pl. LXVII, figs. 4a and 4a′) resembles the low form of *A. ophirensis* Walcott with the apex overhanging the false area. The surface of the shells embedded in the fine-grained sandstone has a papillose surface resulting from the indenting of the shell by the grains of sand, whereas those from limestone are marked only by fine concentric striæ.

FORMATION AND LOCALITY.—**Middle Cambrian:** (11k) *Sandstones of the "Edgewise beds," beneath the Elvins formation, St. Francois County;* and (11e) thin-bedded limestones south-southwest of Potosi, Washington county; both in Missouri.

ACROTRETA MICROSCOPICA TETONENSIS Walcott.

Plate LXVII, figures 3, 3a–d.

Acrotreta microscopica tetonensis WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 590. (Characterized as below as a new variety.)

This neat little shell possesses the characters of *Acrotreta microscopica* (Shumard) and *A. idahoensis* Walcott, but differs from both by the projection of the apex of the ventral valve

over the false area. All that is known of it is represented by the illustrations (Pl. LXVII, figs. 3, 3a–d).

The varietal name is derived from the Teton Mountains, Wyoming.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**4e**) Limestones about 950 feet (289.6 m.) above the unconformable base of the Cambrian in the divide at the head of Jackson Creek (locally known as Sheep Creek), a creek flowing into Jackson Lake about 0.5 mile (0.8 km.) south of its northwestern corner, Teton Mountains, Grand Teton quadrangle (U. S. Geol. Survey), Uinta County, Wyoming.

ACROTRETA? MINIMA (Barrande).

Plate LXXVII, figures 7, 7a.

Obolus? minimus BARRANDE, 1879, Système silurien du centre de la Bohême, vol. 5, pt. 1, Pl. XCV, figs. II: 1–5. (Not described, but figured as a new species. Figs. 3A and 1A are reproduced in this monograph, Pl. LXXVII, figs. 7 and 7a, respectively.)

This minute shell may possibly belong with *Acrothele*, but with the data furnished by the illustrations of Barrande [1879b, Pl. XCV, figs. II:1–5] a provisional reference is made to *Acrotreta*. It certainly is not an *Obolus*. The figures illustrate all the characters known.

FORMATION AND LOCALITY.—**Lower Ordovician:** (**303d** [Barrande, 1879b, Pl. XCV]) Étage dI, Swarow, Bohemia, Austria-Hungary.

ACROTRETA MISERA (Billings).

Plate LXXII, figures 2, 2a–l.

Obolella? miser BILLINGS, 1872, Canadian Naturalist, 2d ser., vol. 6, No. 4, pp. 470–471. (Described and discussed.)

Obolella? miser BILLINGS, 1874, Geol. Survey Canada, Paleozoic Fossils, vol. 2, pt. 1, p. 69. (Copy of preceding reference.)

Linnarssonia misera (Billings), MATTHEW, 1886, Trans. Roy. Soc. Canada for 1885, 1st ser., vol. 3, sec. 4, No. 4, pp. 35–36, Pl. V, figs. 12, 12a–e. (Described and discussed.)

Linnarssonia misera (Billings), HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 108–109, Pl. III, figs. 35–37. (Mentioned. Figs. 35 and 36 are drawn from the specimens figured by Matthew, 1886, Pl. V, figs. 12c and 12, respectively.)

Acrotreta miser (Billings), WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 590–591. (Described essentially as below.)

The abundant material representing this species that I collected in Newfoundland gives illustrations that present its characters with such fullness and detail that minute description is unnecessary. Plate LXXII, figures 2, 2a–e of the ventral valve, show variation in outline, also of the cast of the apical callosity, cardinal scars, and base of main vascular sinuses. Figures 2h–l illustrate the interior of the dorsal valve.

The outer surface is marked by fine concentric striæ and growth lines, and the inner layers or lamellæ by very fine radiating striæ. The minute pedicle aperture is on the back side of the apex, opening almost posteriorly in some examples.

This is a small species, averaging from 1.5 to 2.5 mm. in length.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**1** and **2**) Shales of zones A and B, respectively, of No. 7 of the Manuels Brook section [Walcott, 1891b, p. 261], Manuels Brook, Conception Bay; (**314** [*Billings, 1872b, p. 470*]) *Paradoxides zone on Chapple Arm, Trinity Bay;* (**314h**) shale on Manuels Brook, Conception Bay; (**6g**) limestone near the base of the Middle Cambrian, northwest side of Chapple Arm Harbor, about 1 mile (1.6 km.) from its head, Trinity Bay; (**6h**) limestone in the southwest cove of Chapple Arm, Trinity Bay; and (**6r**) limestone on the west side of Manuels Brook, Conception Bay; all in Newfoundland.

(**2s** and **2t**) Shales and interbedded limestones in the upper part of the *Paradoxides* zone, Hastings Cove [Matthew, 1898b, p. 38], on Kennebecasis Bay, 0.5 mile (0.8 km.) northeast of Torryburn, on the Intercolonial Railway, northeast of St. John; and (**3011** [Matthew, 1886, p. 36]) shale of Division 1d of Matthew, on Porters Brook, St. Martins; both in St. John County, New Brunswick, Canada.

ACROTRETA NEBOENSIS Walcott.

Plate LXXVII, figures 9, 9a–b.

Acrotreta neboensis WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 300–301. (Described as below as a new species.)

Ventral valve moderately elevated, the apex projecting slightly over the nearly vertical false area. The latter is marked midway by a very narrow false pedicle furrow. The transverse

dorsal valve has a strong median depression which starts on the umbo and widens out rapidly toward the front.

The surface of the shell is marked by concentric ridges and lines of growth and very fine concentric striæ.

Observations.—This is one of the *Acrotreta idahoensis* forms of the genus. It differs from other described forms in the strong median depression of the dorsal valve.

The specific name is derived from Mount Nebo Canyon, the type locality.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**14t**) Limestone lying on slope between the Cambrian quartzite and the massive blue limestone 100 feet (30.5 m.) above, in Mount Nebo Canyon, 3 miles (4.8 km.) southeast of Mona, Juab County, Utah.

ACROTRETA NICHOLSONI Davidson.

Plate LXXIII, figures 1, 1a–k, 6, 6a–b.

Acrotreta? nicholsoni DAVIDSON, 1868, Geol. Mag., vol. 5, pp. 313–314, Pl. XVI, figs. 14–16. (Described and discussed as a new species; see below for copy of description. Figs. 14, 15, and 16 are reproduced in this monograph, Pl. LXXIII, figs. 1, 1c, and 1d, respectively.)

Acrotreta? nicholsoni DAVIDSON, 1871, British Fossil Brachiopoda, vol. 3, pt. 7, No. 4, pp. 343–344, Pl. XLIX, figs. 36–40. (Described and discussed. Figs. 36, 37, and 40 are copied from figs. 15, 14, and 16, respectively, of the preceding reference. Figs. 38 and 39 are reproduced in this monograph, Pl. LXXIII, figs. 1a and 1b, respectively.)

Acrotreta nicholsoni Davidson, SWANSTON, 1877, Proc. Belfast Naturalists' Field Club, Appendix 4 for 1876–77, Pl. VII, figs. 21a–c. (Not described. Figs. 21b and 21c are copied from Davidson, 1868, Pl. XVI, figs. 14a and 14b.)

Acrotreta nicholsoni DAVIDSON, 1883, British Fossil Brachiopoda, vol. 5, pt. 2, p. 213, Pl. XVI, figs. 21–23. (New localities mentioned and new figures given. Figs. 21a, 21c, 21b, 22a, 22b, 21d, and 22c are reproduced in this monograph, Pl. LXXIII, figs. 1e–1k, respectively.)

Acrotreta nicholsoni Davidson, SWANSTON, 1886, Systematic Lists, Flora, Fauna, Paleontology, and Archæology, North of Ireland, vol. 1, Pl. VII, figs. 21a–c. (Reprint of Swanston, 1877, Pl. VII, figs. 21a–c.)

Acrotreta nicholsoni Davidson, HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 103, fig. 59. (Mentioned in the text and fig. 59 copied from Davidson, 1868, Pl. XVI, fig. 16a.)

The original description by Davidson follows:

Shell small, about 2 lines in length by about the same in breadth, almost circular; rather wider and broadly rounded anteriorly; nearly straight posteriorly; dorsal valve very slightly convex; ventral valve conical; apex subcentral and truncated by a minute circular foramen, situated at a little more than one-third of the length of the valve. From the center of the posterior margin a narrow groove or channel extends to the base of the foramen, while on either side a small, flattened triangular space or false area (?) is limited by an indented line. Surface of both valves marked with numerous concentric lines of growth.

Subsequently Davidson obtained some less-compressed specimens and reillustrated [1883, Pl. XVI, figs. 21–23] the species. In order to bring before the student all available information I have reproduced most of Davidson's figures.

Observations.—*A. nicholsoni* is one of the largest species of the genus and one of the latest in point of time. Davidson [1883, Pl. XVI, figs. 21–23] illustrates specimens 5 to 6 mm. in length, and it ranges up into the Llandeilo.

The strongly marked false area and the high ventral valve serve to distinguish this species.

The specific name was given in honor of Nicholson.

FORMATION AND LOCALITY.—**Lower Ordovician**: (**316** [*Davidson, 1871, p. 343*]) *Upper Llandeilo (?) black shales, at Dobbs Linn, near Moffat, Dumfricsshire;* and (**316a** [Davidson, 1883, p. 213]) Llandeilo at Craighead, Ardmillan Brae, and Balcletchie, all in the Girvan district of Ayrshire; both in Scotland.

(**317** [Davidson, 1883, p. 213]) Coalpit Bay, County Down, Ireland.

Upper Cambrian: (**304h**) Shineton shales at Mary Dingle, South Shropshire; and (**304a** [Groom, 1902, p. 110]) "Bronsil" shales, Malvern Hills; both in England.

ACROTRETA NOX Walcott.

Plate LXXVII, figure 10.

Acrotreta nox WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 301. (Characterized as below as a new species.)

This minute shell, 1 mm. in length, is characterized by its low ventral valve, nipple-like apex, and apparently smooth surface.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**10v**) Shales in "St. Croix sandstone," at Fox Glen, 8 miles (12.8 km.) east of Baraboo, Sauk County, Wisconsin.

Acrotreta œlandica Westergård.

Acrotreta oelandica Westergård, 1909. Medd. från Lunds Geol. Fältklubb, Ser. B, No. 4 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 20), p. 76, Pl. V, figs. 24a–b. (Described in Swedish as a new species; see below for translation.)

The original description by Westergård follows:

Apex situated near the posterior border. Along the latter there is a faintly defined triangular area which occupies one-fourth of the periphery of the shell. The shell is about half as high as broad. Surface smooth, with fine distinct growth lines, which, although more faintly, are also to be seen on the area. The slope from the apex to the anterior border is slightly concave, though this is likely a secondary phenomenon due to pressure. The apex itself has not been preserved.

Formation and locality.—**Upper Cambrian:** (**310r**) *Zone v of the Ceratopyge slate at Ottenby, Oeland Island;* and (**310s**) uppermost part of the alum slate in beds equivalent to the *Ceratopyge* slate, northern part of Oeland Island; both [Westergård, 1909, p. 76] in Sweden.

Acrotreta ophirensis Walcott.

Plate LXXIV, figures 1, 1a–p.

Acrotreta ophirensis Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 591–592. (Described as below as a new species.)

General outline transversely broad oval, sometimes nearly circular, with the posterior margin slightly indented midway on the ventral valve by incurving to the false pedicle furrow. The ventral valve is convex and moderately elevated, the highest point being in front of the pedicle aperture at about one-third the diameter of the shell. Pedicle aperture large for the size of the shell and opening either directly or obliquely backward; one specimen shows an obscure, short, narrow, triangular false area, with a vertical furrow crossing it (Pl. LXXIV, fig. 1a″); false area scarcely defined by the cardinal slopes, which incurve very gently; median furrow well defined, rather strong, and nearly flat on the bottom, the margins being sharply outlined in many specimens. Some of the shells curve over the false area so that the depressed apex extends slightly beyond the posterior margin, but generally it is directly on the line of, or a little in front of, the posterior margin.

Longitudinal diameter of average size ventral valve 3 mm., with a length of 2 to 2.5 mm.; elevation, 1.5 mm. A few shells have nearly the same length and width. The convexity of the dorsal valve averages 0.75 mm. The minute beak of the dorsal valve curves down to the posterior margin from the somewhat swollen posterior third of the valve.

Surface marked by fine concentric striæ and lines of growth, some of which form concentric ridges. The shell is built up of a thin outer layer and numerous thin inner layers or lamellæ that are oblique to the outer layer over the central and outer portions, the obliquity increasing toward the outer anterior and lateral margins.

The interior of the ventral valve shows a rather strong apical callosity that extended nearly to the posterior inner margin of the shell; distinct, but relatively small cardinal scars, and narrow main vascular sinuses that may be traced nearly to the anterolateral margins of the valve. The outlines of the visceral cavity are indicated on one well-preserved cast of the interior of the valve (Pl. LXXIV, fig. 1e). The interior of the dorsal valve shows great variation in the size and length of the median ridge and cardinal and central scars; these characters are fully shown in the numerous illustrations of the interior and casts of the interior of the dorsal valve.

Observations.—This species is most closely related to *Acrotreta curvata* Walcott. It differs in the ventral valve being larger, in the apex being less extended over the false area, and the form of the median furrow, which is like that of *A. attenuata* Meek. Although the shells occur in a compact unaltered limestone, there is more or less distortion in the outline of both valves; this, taken in connection with the variation in form and size of the vascular markings, muscle scars, and median ridge of the dorsal valve, might serve to discriminate several so-called varieties, but I have given names to only two of the more pronounced varieties.

Similar forms occur in a compact, dark, bluish-gray limestone more than 200 miles to the north in the Wasatch Mountains, east of Cache Valley, on the line of the Ute Peak section of the Fortieth Parallel Survey.

The specific name is derived from Ophir, the type locality.

FORMATION AND LOCALITY.—**Middle Cambrian:** (3e) *Limestone less than 400 feet (121.9 m.) above the quartzitic sandstones of the Cambrian, at Ophir, Oquirrh Range, Tooele County, Utah.*

(**30n**) About 3,750 feet (1,143 m.) above the Lower Cambrian and 650 feet (198 m.) below the Upper Cambrian, in the shaly limestones forming 1c of the Weeks limestone [Walcott, 1908f, p. 175], on the north side of Weeks Canyon, about 4 miles (6.4 km.) south of Marjum Pass; (**30g**) about 2,350 feet (716.3 m.) above the Lower Cambrian and 2,050 feet (624.8 m.) below the Upper Cambrian in the limestone forming 1c of the Marjum limestone; and (**3x** and **3y**) about 2,200 feet (670.6 m.) above the Lower Cambrian and 2,200 feet (670.6 m.) below the Upper Cambrian in the shaly limestones forming 1d of the Marjum limestone [Walcott, 1908f, p. 180], in the ridge east of Wheeler Amphitheater; all in the House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah.

(**31z** and **55t**) About 350 feet (106.7 m.) above the Brigham quartzite in limestone of the Ute limestone [Walcott, 1908f, p. 7], on west side of road, 0.5 mile (0.8 km.) above the forks, Paradise Dry Canyon (locally known as East Fork), east of Paradise, Cache County, Utah.

ACROTRETA cf. OPHIRENSIS Walcott.

Numerous compressed specimens of shells about the size of *Acrotreta ophirensis* Walcott occur in strata of Middle Cambrian age at various localities in Utah. They resemble the latter species in size, occasional strong lines of growth, position of the apex of the ventral valve, and strong cardinal muscle scars in the dorsal valve; they differ in being much less convex, and in having only a trace of shell substance; the removal of the shell by solution and the compression in the shale accounts very largely for the differences. The stratigraphic position of the two forms is about the same and they both lived in the eastern portion of the Cordilleran Middle Cambrian Sea.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**32j**) 625 feet (190.5 m.) above the top of the Cambrian quartzitic sandstone in pinkish-colored very fine grained arenaceous shale, 2 miles (3.2 km.) southeast of Muskrat Spring, on the northwest face of Grantsville Peak, Stansbury Range, Tooele County, Utah.

(**31v**) 650 feet (198.1 m.) above the Lower Cambrian and 3,750 feet (1,143 m.) below the Upper Cambrian, in shales at the top of the limestone forming 1a of the Howell formation [Walcott, 1908f, p. 182], northeast side of Dome Canyon, about 4 miles (6.4 m.) west-southwest of Antelope Springs; (**11y** and **30g**) about 2,350 feet (716.3 m.) above the Lower Cambrian and 2,050 feet (624.8 m.) below the Upper Cambrian in 1c of the Marjum limestone [Walcott, 1908f, p. 180], ridge east of Wheeler Amphitheater; and (**31s**) 490 feet (149.4 m.) above the Lower Cambrian and 3,925 feet (1,196.3 m.) below the Upper Cambrian, in the pinkish argillaceous shale forming 1d of the Howell formation [Walcott, 1908f, p. 182], south side of Dome Canyon about 1 mile (1.6 km.) below the divide, and 3 miles (4.8 km.) west-southwest of Antelope Springs; all in the House Range [Walcott, 1908f, Pls. XIII and XVI], Millard County, Utah.

(**31c**) About 900 feet (274.3 m.) above the Brigham quartzite and 3,300 feet (1,005.8 m.) below the Upper Cambrian, in the limestone forming 1b of the Ute limestone [Walcott, 1908f, p. 196], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County; (**32c**) about 60 feet (18.3 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], in green shale, 1 mile (1.6 km.) northwest of Geneva (Copenhagen), east of Brigham, Boxelder County; and (**30u**) about 250 feet (76.2 m.) above the Cambrian quartzitic sandstones in sandy shales, 4 miles (6.4 km.) northwest of Promontory Point (on the "Lucin cut-off" of the Union Pacific Railway), about halfway up west end of ridge, north of Great Salt Lake, Boxelder County; all in Utah.

ACROTRETA OPHIRENSIS DESCENDENS Walcott.

Plate LXXVIII, figures 1, 1a–c.

Acrotreta ophirensis descendens WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 95, Pl. IX, figs. 1 and 1a. (Discussed as below as a new variety. Figs. 1 and 1a are copied in this monograph, Pl. LXXVIII, figs. 1 and 1c, respectively.)

In the Cambrian section of the House Range, Utah, the typical forms of *Acrotreta ophirensis* occur in the Marjum limestone; 1,570 feet higher in the section, in the Weeks limestone, there are great numbers of a shell identical in many respects. This latter shell differs from the typical form in being less convex in both the ventral and dorsal valves, and in having a more pointed, less curved apex on the ventral valve.

This form owes its varietal name to the fact that it occurs higher in the section than the species, and is probably descendant from it.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**30n**) About 3,750 feet (1,143 m.) above the Lower Cambrian and 650 feet (198 m.) below the Upper Cambrian in shaly limestones forming 1c of the Weeks limestone [Walcott, 1908f, p. 175], on the north side of Weeks Canyon, about 4 miles (6.4 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County, Utah.

ACROTRETA OPHIRENSIS RUGOSA Walcott.

Plate LXXIV, figures 2, 2a–e.

Acrotreta ophirensis rugosus WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 592. (Characterized as below as a new variety.)

This form is associated with *Acrotreta ophirensis* Walcott in considerable numbers. It is characterized by strong, rugose growth lines and thicker shell.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**3e**) Thin-bedded limestone, less than 400 feet (121.9 m.) above the quartzitic sandstones of the Cambrian, at Ophir, Oquirrh Range, Tooele County, Utah.

ACROTRETA OVALIS Walcott.

Plate LXVI, figures 2, 2a–b.

Acrotreta ovalis WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 592. (Characterized as below as a new species.)

In material received from the Geological Survey of Canada in answer to a request for the specimens representing *Acrotreta gemma* Billings, there was one ventral valve embedded in a smooth, dove-colored limestone from Point Levis. This specimen differs materially from *A. gemma* in the oval outline of the rim of the shell, less elevated apex, and less well-defined false area. It is more of the type of *A. schmalenseei* Walcott, and of *A. microscopica* (Shumard) of the interior continental species than any of the Atlantic Province forms.

FORMATION AND LOCALITY.—**Lower Ordovician:** (**319** [Geol. Survey, Canada]) Limestone No. 1 of Billings's Point Levis Section, Point Levis, Province of Quebec, Canada.

ACROTRETA PACIFICA Walcott.

Plate LXIX, figures 6, 6a–e.

Acrotreta pacifica WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 301. (Described below as a new species.)

Ventral valve a high cone, with the apex a little in advance of the posterior margin; base circular, with the exception of a slight flattening on the posterior side; apex acute and pointing upward; false area only a slight flattening of the shell from the apex to the margin. The largest ventral valve has a diameter and height of about 1.5 mm. Surface marked by fine concentric striæ that continue without noticeable deflection across the false area.

Observations.—Only two specimens of the ventral valve of this species occur in the collection. One of these has a slightly transverse, broadly oval base, and a more definite false area. The species is closely related to *Acrotreta idahoensis alta* Walcott except that the ventral valve is not quite as elevated.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**C1** and **C2**) Lower shale member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 40 (part of the 3d list of fossils) and fig. 10 (beds 4 and 5), p. 38], 2 miles (3.2 km.) south of Yenchuang; (**C12**) gray limestone near the top of the middle limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 41 (part of the first list of fossils) and fig. 10 (bed 7), p. 38], 3.25 miles (5.2 km.) southwest of Yenchuang; (**C5**) *lower limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 39 (first list of fossils), and fig. 8a (bed 30), p. 29], 3.2 miles (5.1 km.) southwest of Yenchuang;* and (**C4**) limestone nodules at the base of the lower shale member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 40 (2d list of fossils), and fig. 10 (bed 4), p. 38], 3 miles (4.8 km.) southwest of Yenchuang; all in the Sintai district, Shantung, China.

ACROTRETA PARVULA (Wallerius).

Plate LXXVII, figures 4, 4a.

Obolella parvula WALLERIUS, 1895, Undersökningar öfver Zonen med *Agnostus lævigatus* i Vestergötland, pp. 65–66, figs. 9a–d. (Described in Latin, and discussed in Swedish.)

Acrotreta parvula (Wallerius), WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 592. (Described as on p. 700.)

Shell minute, subcircular. Ventral valve relatively depressed, the highest point being at the umbo, from which there is a slight downward curvature to the apex. False area low and about vertical, the apex being on a line with the posterior margin. Dorsal valve slightly convex; beak marginal. Surface marked by fine concentric striæ.

Observations.—This minute species occurs with *Agnostus lævigatus* in the upper portion of the Middle Cambrian. It is of the *Acrotreta sagittalis* (Salter) type, but does not appear to be identical with the young of that species.

Formation and locality.—**Middle-Upper Cambrian**: (**310i**) Passage beds between the Middle Cambrian *Paradoxides forchhammeri* zone and the Upper Cambrian *Olenus truncatus* zone, limestone at Borgholm, Oeland Island, Sweden.

Middle Cambrian: (**320**) Gudhem, 12.5 miles (20.1 km.) south-southeast of Skara; and (**320a**) *Djupadal, 19 miles (30.6 km.) south-southeast of Skara;* both [Wallerius, 1895, p. 66] in the Province of Skaraborg, Sweden.

Acrotreta primæva Walcott.

Plate LXIX, figures 1, 1a–f.

Acrotreta gemma Walcott (in part) [not Billings], 1886, Bull. U. S. Geol. Survey No. 30, pp. 98–99, Pl. VIII, figs. 1, 1a–b. (Specimens now referred to *Acrotreta pyxidicula* and *A. attenuata* were included with the specimens representing *A. primæva* when this description of *A. gemma* was written, but they were not figured. The two specimens represented by figs. 1b and 1, 1a are redrawn in this monograph, Pl. LXIX, figs. 1c and 1, respectively.)

Acrotreta gemma Walcott (in part) [not Billings], 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 608, Pl. LXVII, figs. 5c, 5d, and 5e (not figs. 5, 5a–b, see below). (Figs. 5c, 5d, and 5e are copied from figs. 1a, 1, and 1b, respectively, of preceding reference. Specimens now referred to *Acrotreta attenuata*, *A. idahoensis alta*, and *A. curvata* were included with the specimens representing *A. primæva* in this reference to *A. gemma*, but only the last two were figured: *A. idahoensis alta*, Pl. LXVII, figs. 5 and 5a, and *A. curvata*, Pl. LXVII, fig. 5b.)

Acrotreta gemma Walcott (in part) [not Billings], 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, p. 449, Pl. LXII, figs. 2, 2b, and 2d (not figs. 2a, 2c, and 2e, see below). (Figs. 2, 2b, and 2d are copied from Walcott, 1886b, Pl. VIII, figs. 1, 1a, and 1b, respectively. Specimens now referred to *Acrotreta pyxidicula*, *A. attenuata*, *A. idahoensis alta*, and *A. curvata* were included with the specimens representing *A. primæva* when this description of *A. gemma* was written, but only the last two were figured; *A. idahoensis alta*, Pl. LXII, figs. 2a and 2c, and *A. curvata*, Pl. LXII, fig. 2e.)

Acrotreta primæva Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 593. (Described essentially as below as a new species.)

Acrotreta gemma Walcott, Grabau and Shimer [not Billings], 1907, North American Index Fossils, vol. 1, p. 199, figs. 234a–c. (Described, and figures copied from Walcott [1886b, Pl. VIII] figs. 1a, 1, and 1b, respectively.)

Outline of valves transversely oval to subcircular. Ventral valve subconical, with the apex at the summit of the false area near or just above the posterior margin. The elevation varies from one-half to two-thirds the diameter of the shell. The false area is quite clearly defined in most specimens; it varies in width at the posterior margin from one-third to nearly one-half of the diameter of the shell; the path of advance of the pseudodeltidium is marked usually by a narrow incised line similar to that of *Acrotreta attenuata* Meek. Foraminal aperture minute and situated at the apex of the cone. Dorsal valve slightly convex, with a minute beak slightly incurved over the posterior margin. A broad, slightly defined median sinus flattens the front and central portion of the valve, but it is not perceptible toward the umbo and beak. Surface of the shell marked by fine concentric striæ and occasional ridges of growth; on some shells there is a very fine, almost microscopic, irregular, concentric striation that gives a fretted surface somewhat similar to that of *Obolus* (*Westonia*) *ella* (Hall and Whitfield). The inner lamellæ of the shell and the interior surface have traces of fine radiating striæ that, with the irregular concentric striæ, give a broken, subimbricated, fretted effect to the surface. The shell is formed of a thin outer layer and several thin inner layers or lamellæ, the outer ones of which are slightly oblique to the outer surface layer. The largest shells have a transverse diameter of 5.5 mm., longitudinal diameter 5 mm., height of ventral valve 3 mm.; dorsal valve 1 mm. The interior of a slightly crushed ventral valve, figure 1e, shows the cast of an apical callosity, strong vascular canals, and faint outlines of the visceral cavity. The cast of an interior of a dorsal valve has a long, well-defined median ridge, cardinal scars, and faintly defined central scars, as illustrated by figures 1d and 1f. Interiors of the ventral valve from near

Cherry Creek show two relatively small cardinal scars near the posterior margin, and a small subtriangular apical callosity.

Observations.—This, the oldest species of the genus known to me, has all the essential characters of the type species as far as the available information permits of comparison. It is one of the largest shells of the genus, and is a striking feature of the fauna of the higher portion of the *Olenellus* zone of central Nevada. The most nearly related species appears to be *A. attenuata* Meek (Pl. LXIV, fig. 1).

FORMATION AND LOCALITY.—**Middle Cambrian:** (7j) Limestones at the north end of the Quinn Canyon Range, 1 mile (1.6 km.) northwest of the Italian Ranch foothills, Nye County, Nevada.

Lower Cambrian: (41) Limestone in the Pioche formation [Walcott, 1908a, p. 11] on a ridge 2.5 miles (4 km.) northwest of the town of Cherry Creek, White Pine County; and (31a) *limestone and interbedded siliceous shales of the Pioche formation [Walcott, 1908a, p. 11], just above the quartzite on the east side of the anticline, near Pioche, Lincoln County;* both in Nevada.

ACROTRETA PYXIDICULA White.

Plate LXIX, figures 2, 2a–f, 3, 3a–f.

Acrotreta pyxidicula WHITE, 1874, U. S. Geog. Surveys W. 100th Mer., Prelim. Rept. Invertebrate Fossils, p. 9. (Described as a new species.)

Acrotreta pyxidicula WHITE, 1877, U. S. Geog. Surveys W. 100th Mer., vol. 4, pt. 1, pp. 53–54, Pl. III, figs. 3a–d. (Described essentially as in preceding reference. The specimens represented by figs. 3a–b and 3c–d are redrawn in this monograph, Pl. LXIX, figs. 2 and 2f, respectively.)

Acrotreta gemma WALCOTT (in part) [not BILLINGS], 1884, Mon. U. S. Geol. Survey, vol. 8, pp. 17–18. (Specimens representing *Acrotreta attenuata, A. curvata,* and *A. idahoensis alta* were included with the specimens representing *A. pyxidicula* when this description of *A. gemma* was written, but only the last two are known to have been figured: *A. curvata,* Pl. I, figs. 1d and 1e, and *A. idahoensis alta,* Pl. I, figs. 1a and 1b. The specimens represented on Pl. IX, figs. 9 and 9a, can not be positively located at this time, but it is probable that they should be referred to *A. idahoensis alta.*)

Acrotreta gemma WALCOTT (in part) [not BILLINGS], 1886, Bull. U. S. Geol. Survey No. 30, pp. 98–99. (Specimens now referred to *Acrotreta attenuata* and *A. primæva* were included with the specimens representing *A. pyxidicula* when this description of *A. gemma* was written, *A. primæva* being figured, Pl. VIII, figs. 1, 1a–b.)

Acrotreta gemma WALCOTT (in part) [not BILLINGS], 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 608. (Specimens now referred to *Acrotreta attenuata, A. curvata, A. idahoensis alta,* and *A. primæva* were included with the specimens representing *A. pyxidicula* in this reference to *A. gemma,* the last three being figured: *A. curvata,* Pl. LXVII, fig. 5b; *A. idahoensis alta,* Pl. LXVII, figs. 5 and 5a; and *A. primæva,* Pl. LXVII, figs. 5c, 5d, and 5e.)

Acrotreta gemma WALCOTT (in part) [not BILLINGS], 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, p. 449. (Specimens now referred to *Acrotreta attenuata, A. curvata, A. idahoensis alta,* and *A. primæva* were included with the specimens representing *A. pyxidicula* when this description of *A. gemma* was written, the last three being figured: *A. curvata,* Pl. LXII, fig. 2e; *A. idahoensis alta,* Pl. LXII, figs. 2a and 2c; and *A. primæva,* Pl. LXII, figs. 2, 2b, and 2d.)

This is a small and very pretty species in which the interiors of the two valves are fairly well shown by casts. A marked feature of the ventral valve is the very strong vascular sinus (fig. 3f), and of the dorsal valve the thickening of the shell in the posterior portion (fig. 3e). The surface of the shell is marked by fine concentric striæ and occasional lines of growth. It is one of the small species of the genus, the average size being from 1.5 to 2 mm. Of the known species it may be compared with *A. idahoensis* Walcott (Pl. LXV) from which it differs in the slighter elevation of its ventral valve and the incised median line on the false area.

FORMATION AND LOCALITY.—**Upper Cambrian:** (313f) *Limestone at Schellbourne, Schell Creek Range, White Pine County, Nevada.*

(329d) Limestone near Fish Springs, Fish Spring Range, Juab County, Utah.

Middle Cambrian: (7j) Limestone at the north end of the Quinn Canyon Range, 1 mile (1.6 km.) northwest of the Italian Ranch foothills, Nye County; and (60) limestone in upper beds of Secret Canyon shale, across the canyon from the dump of the old Richmond mine shaft, Eureka district [Hague, 1892, Atlas], Eureka County; all in Nevada.

(30z) About 2,450 feet (746.8 m.) above the Lower Cambrian and 1,950 feet (594.4 m.) below the Upper Cambrian, in the upper part of the limestone forming 1c of the Marjum limestone [Walcott, 1908f, p. 180], in the long cliff about 2 miles (3.2 km.) southeast of Marjum Pass, House Range [Walcott, 1908f, pls. XIII and XV], Millard County, Utah.

(5b and 54s) Dark blue-gray Langston limestone [Walcott, 1908f, p. 198], just above the Cambrian quartzitic sandstones, north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County; (59f) limestones immediately underlying the Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], in a saddle

north of the creek which flows into Mill Canyon from the west, about 5 miles (8 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County; and (322) limestone (stratigraphic position unknown) about 6 miles (9.6 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County; all in Idaho.

(4h) About 375 feet (114.3 m.) above the base of the Cambrian in the limestone interbedded in the Flathead shales of Peale [1893, p. 21], 1 mile (1.6 km.) north of the junction of East Gallatin and West Gallatin (Gallatin) rivers, 4 miles (6.4 km.) east-northeast of Logan, Threeforks quadrangle (U. S. Geol. Survey), Gallatin County, Montana.

Acrotreta rudis Walcott.

Plate LXV, figure 3f; Plate LXXV, figure 1.

Acrotreta kutorgai Walcott (in part), 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 589–590. (Described as a new species, but the description included specimens belonging to both *Acrotreta kutorgai* and *A. rudis*.)

Acrotreta rudis Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 95–96, Pl. IX, fig. 5. (Described and discussed as below as a new species. Fig. 5 is copied in this monograph, Pl. LXV, fig. 3f.)

The specimens illustrating this species are all more or less crushed and flattened on the surface of the fine argillaceous shale in which they are embedded in large numbers, and they are often in the condition of casts of the interior of the valves. This is well shown by the enlargement of a fragment of the shale on which three ventral and three dorsal valves occur (Pl. LXXV, fig. 1).

The ventral valve, as far as can now be determined, was elevated, conical, and with the apex overhanging the false area, so that when the shells were crushed down the posterior side disappeared beneath. A few fragmentary specimens show the false area to have been distinctly defined, of medium height, and marked by a narrow, shallow median furrow extending from the apex to the margin of the valve. Dorsal valve subcircular, slightly transverse, gently convex, and with a minute beak at the posterior margin. The pedicle opening appears to have been of medium size and situated at the apex of the valve.

Surface marked by lines of growth and very fine concentric striæ that continue across the false area and furrow.

The cast of the interior of the ventral valve shows a small but well-defined visceral area in advance of the apex and a short strong main vascular sinus on each side of the area; one cast shows traces of the sinuses nearly to the front margin. The interior of the dorsal valve is marked by a strong median septum or ridge that extends from the front of a small cardinal area forward nearly to the anterior margin in some examples. A large, oval cardinal muscle scar occurs on each side of the median ridge near the posterior border of the valve; the central muscle scars are small, elongate oval and situated on the sides of the median ridge at about the posterior third of the longitudinal axis of the shell; the two anterolateral muscle scars are on the sides of the median ridge a little in advance of the central scars.

This is one of the large species of the genus. A dorsal valve 4 mm. in length has a width of 4.5 mm. The ventral valves average from 4 to 4.5 mm. from the apex to the front margin.

In size and outline this species may be compared with *Acrotreta depressa* (Pl. LXVI, figs. 8, 8a–c) and *A. definita* (Pl. LXIV, figs. 2, 2a–g). It differs from both in its ventral valve being more elongate. All the specimens of *A. rudis* are so flattened in the shale that comparison with uncompressed specimens is very difficult.

Formation and locality.—**Middle Cambrian**: (**101a**) *Rogersville shale, just above the road in the hill west of the schoolhouse, 3.5 miles (5.6 km.) southwest of Rogersville on the road to Melinda Ferry [Keith, 1896a, areal geology sheet];* (**102c**) first shale south of the Estillville pike, 3.5 miles (5.6 km.) east of Rogersville, Greeneville quadrangle (U. S. Geol. Survey); and (**121**) Rogersville shale, road just east of Harlan Knob, 4 miles (6.4 km.) northeast of Rogersville [Keith, 1905, areal geology sheet]; all in Hawkins County, Tennessee.

Acrotreta sabrinæ (Callaway).

Plate LXXIII, figures 5, 5a–d.

Metoptoma sabrinæ Callaway, 1874, Quart. Jour. Geol. Soc. London, vol. 30, pt. 1, p. 196. (Name proposed, not described.)

Obolella sabrinæ Callaway, 1877, idem, vol. 33, pt. 1, p. 669, Pl. XXIV, fig. 12. (Described as a new species. The specimen represented by fig. 12 is redrawn in this monograph, Pl. LXXIII, fig. 5b.)

Obolella sabrinæ (Callaway), Davidson, 1883, British Fossil Brachiopoda, vol. 5, pt. 2, p. 211, Pl. XVI, figs. 27, 27a, 27d, 28, and 28a. (Described and discussed.)

Obolella? scabrinæ (Callaway), Walcott, 1884, Mon. U. S. Geol. Survey, vol. 8, Pl. I, fig. 1c. (Not described, and figure copied from Davidson, 1883, Pl. XVI, fig. 27d.)

Obolella sabrinæ (Callaway), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 103, fig. 58. (Mentioned in the text and figure copied from Davidson, 1883, Pl. XVI, fig. 27d.)

Acrotreta sp. cf. *nicholsoni* Davidson, Matley, 1902, Quart. Jour. Geol. Soc. London, vol. 58, pt. 1, p. 142, fig. 10. (Discussed in text as *Acrotreta* sp., and figured as *A.* sp. cf. *nicholsoni*.)

Acrotreta (*?*) *sabrinæ* (Callaway), Matley, 1902, idem, p. 143. (Discussed.)

Acrotreta (*?*) *sabrinæ malvernensis* Matley, 1902, idem, pp. 143–144, figs. 11–14. (Described and discussed as a new variety.)

Acrotreta sp. cf. *A. socialis* von Seebach, Matley, 1902, idem, pp. 144–145, figs. 15 and 16. (Characterized and discussed.)

As in the case of most species of *Acrotreta* preserved in shales, the ventral valves of this form are so compressed as to prevent our getting the true elevation. With several fairly well-preserved specimens to judge from I think the height was about two-thirds of the greatest diameter of the shell. A partial cast of the interior shows a small apical callosity and the base of the cast of a small pedicle tube. The interior of the dorsal valve is almost bisected by a strong median ridge; the cardinal scars are also prominent.

A fragment of the outer shell shows fine, concentric striæ and lines of growth that are fretted by very fine undulating striæ.

Through the courtesy of Dr. Charles Lapworth I have had the opportunity of studying and illustrating the type specimen of Callaway's "*Obolella sabrinæ*" (Pl. LXXIII, fig. 5b). It is a cast of the dorsal valve preserving little more than the impression of the strong median ridge and a trace of the area. Dr. Lapworth also sent me several other specimens of this species; these are illustrated on Plate LXXIII, figures 5, 5a, 5c, and 5d. Davidson [1883, Pl. XVI, fig. 27d] illustrates an interior of a dorsal valve in which the median ridge and the cardinal and central scars are clearly defined. He also gives [1883, Pl. XVI, figs. 27, 27a] the exterior of a compressed ventral valve and a side view of the two valves united.

Of described species, *Acrotreta bisecta* Matthew approaches this most closely. It is quite probable that with a good series of specimens of each species for comparison the two forms would be referred to the one species of Callaway.

Matley [1902, p. 143, figs. 11–14] illustrates and describes some crushed specimens from the lowest black shales of the Malvern Hills, which he tentatively gives the value of a variety of this species under the name *malvernensis*. With examples from the typical locality before me for comparison with the proposed variety, I am inclined to consider the latter of such doubtful value as to leave it out of this work.

He also [Matley, 1902, p. 144] mentions an *Acrotreta* as sp. cf. *A. socialis* von Seebach from a higher stratigraphic horizon. *Acrotreta socialis* as now restricted is confined to the Middle Cambrian. I do not think that the material as illustrated and described by Matley clearly indicates a form distinct from *Acrotreta sabrinæ*, if allowance is made for the crushed condition of most specimens of the latter species. The shell mentioned as *Acrotreta* sp. cf. *nicholsoni* [Matley, 1902, p. 142] may also be a large specimen of this species.

The shells figured by Matley [1902, p. 141, figs. 7 and 8] as *Lingulella* (*?*) sp. and [1902, p. 142, fig. 10] as *Lingula* (*?*) sp. I think are either *Acrotreta* or *Acrothyra*, probably the latter.

Formation and locality.[a]—**Upper Cambrian**: (**304h** *and* **304i** [*Callaway, 1877, p. 669*]) *Shineton shale, at Shineton, Mary Dingle, Dryton, Cressage, 1 mile (1.6 km.) west of Cressage, west of Harley, and under Cound-Moor quarry, all in South Shropshire, England.*

(**304p**) Shineton shales at the following localities of the Geological Survey of Great Britain: 2495, 2536, 2543, 2545, 2558, and 2580, all of which are on Shineton Brook, South Shropshire, England.

(**304j**) Lower Stockingford shales, Puxley Park lane, halfway up the path to the quarry, Atherstone, Warwickshire; (**304a** [Groom, 1902, p. 110]) "Bronsil" shales, Malvern Hills; and (**304b** [Groom, 1902, p. 109]) lower part of the "White Leaved Oak" shales (the zone of *Polyphyma*), Malvern Hills; all in England.

[a] Localities **304h** and **304j** are the only localities represented in the United States National Museum collections. **304h** is the type locality.

Acrotreta sagittalis (Salter).

Plate LXXI, figures 2, 2a–h, 3, 3a–j.

Obolella sagittalis Salter, 1866, Rept. British Assoc. Adv. Sci. for 1865, p. 285. (Name proposed.)

Discina labiosa Salter, 1866, idem, p. 285. (Name proposed.)

Obolella sagittalis Salter, Davidson, 1868, Geol. Mag., vol. 5, pp. 309–310, Pl. XV, figs. 17–24. (Described and discussed.)

Obolella sagittalis Salter, Davidson, 1871, British Fossil Brachiopoda, vol. 3, pt. 7, No. 4, pp. 339–340, Pl. L, figs. 1–14. (Copy of preceding reference. Figs. 1a, 3a, 4 and 4a, 5 and 5a, 9, 10 and 10a, and 12 and 12a appeared, Davidson, 1868, Pl. XV, as figs. 17a, 21a, 23 and 23a, 19 and 19a, 22a, 20 and 20a, and 24 and 24a, respectively.)

Obolella sagittalis Salter, Linnarsson, 1876, Bihang till K. svensk. Vet.-Akad. Handl., Bd. 3, No. 12, pp. 19–20, Pl. III, figs. 36–41. (Described and discussed in English.)

Obolella sagittalis Salter, Linnarsson, 1879, Sveriges Geol. Undersökning, Afhandl. och Uppsatser, Ser. C, No. 35, pp. 27–28, Pl. III, figs. 45–49. (Described in Swedish.)

Obolella sagittalis Salter, Brögger, 1882, Die silurischen Etagen 2 und 3, p. 45, Pl. X, figs. 6–8. (Described and discussed in German.)

Obolella sagittalis Salter, Davidson, 1883, British Fossil Brachiopoda, vol. 5, pt. 2, p. 211, Pl. XVI, figs. 25–26. (Gives new localities and new figures.)

Linnarssonia sagittalis (Salter), Walcott, 1885, Am. Jour. Sci., 3d ser., vol. 29, p. 115, figs. 5 and 8. (Merely refers the species to *Linnarssonia*. Figs. 5 and 8 are copied from Davidson, 1868, Pl. XV, figs. 22a and 23a, respectively.)

Obolella ida? Dawson, 1888, Canadian Rec. Sci., vol. 3, p. 55. (Possible occurrence discussed.)

Obolella ida? Dawson, 1888, Peter Redpath Museum, Montreal, Canada; Notes on Specimens, April, 1888, p. 55.

Obolella (Linnarssonia) pretiosa Dawson, 1890, Trans. Roy. Soc. Canada for 1889, 1st ser., vol. 7, sec. 4, No. 3, pp. 53–54, figs. 26a–c. (Discussed.)

Linnarssonia cf. *pretiosa* Dawson, Hall, 1890, idem, p. 55. (Description of the specimens discussed in preceding reference.)

Linnarssonia sagittalis (Salter), Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, Pl. LXVIII, figs. 2a–d. (Not described.)

Linnarssonia pretiosa (Dawson), Hall and Clarke, 1892, Nat. Hist., New York, Paleontology, vol. 8, pt. 1, p. 70, Pl. III, figs. 43–44. (Discussed. Figs. 43–44 are copied from Dawson, 1890, figs. 26a–c, p. 53.)

Linnarssonia sagittalis (Salter), Hall and Clarke, 1892, idem, p. 108, figs. 60–61. (Discussed. The figures are copied from Davidson, 1868, Pl. XV, figs. 22a and 23a, respectively.)

Linnarssonia pretiosa (Dawson), Schuchert (in part), 1897, Bull. U. S. Geol. Survey No. 87, p. 262. (Mere reference, but includes specimens now referred to both *Acrothele pretiosa* and *Acrotreta sagittalis*.)

Linnarssonia sagittalis (Salter), Frech, 1897, additional plates inserted in 1897 in Lethæa geognostica, pt. 1, Lethæa palæozoica, Atlas, 1876, Pl. IA, fig. 3a. (No text reference. Fig. 3a is copied from Walcott, 1891a, Pl. LXVIII, fig. 2.)

Obolella cf. *sagittalis* Salter, Wiman, 1902, Bull. Geol. Inst. Univ. Upsala, vol. 6, pt. 1, No. 11, p. 66. (New localities mentioned.)

Obolella (Acrotreta?) sagittalis (Salter), Moberg and Segerberg, 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), p. 64, Pl. I, figs. 25 and 26. (Characterized in Swedish.)

?Linnarssonia pretiosa Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 200. (Described, but not figured, and it is impossible to tell whether the authors are discussing the *L. pretiosa* that is now referred to *Acrotreta sagittalis*, or the true *Acrothele pretiosa*.)

Although I have examined a large collection of this species, both from Wales and Sweden, good exteriors of the valves have not been observed. The apex of the ventral valve almost invariably remains in the matrix, or the shell has been removed by solution. The convexity of the two valves is approximately the same (figs. 3c and 3d, Pl. LXXI) except that the ventral valve is more elevated near the apex. The apex is situated a little in front of the posterior margin at the edge of the slightly defined false area which slopes forward at an angle of 70° to 80°. The surface of the shell is marked by rather strong concentric striæ and often strong ridges of growth and very fine radiating striæ on the interior layers. The shell is built up of thin layers or lamellæ of a calcareocorneous nature. The average diameter of specimens from St. Davids, Wales, is 2.5 mm. The representatives of the species from Andrarum, Sweden, are usually smaller than the St. Davids shells but otherwise appear to be identical.

The interior of the ventral valve is shown by numerous casts. The apical callosity and the cardinal scars are usually large. The visceral cavity is sometimes outlined in front of the callosity and between the clearly marked main vascular sinuses. Casts of the interior of the

dorsal valve show a remarkable range of variation in the length and size of the median ridge (Pl. LXXI, figs. 3e, 3g–j). Within the extremes of variation specific characters could be established.

This species has had a varied experience at the hands of paleontologists. Davidson [1871, Pl. L, figs. 1–14] elaborately illustrated the casts of the interiors of the valves, and I [1885, p. 116] copied some of his figures when preparing the description of the genus *Linnarssonia*. When in Wales in 1888, I collected a quantity of material at St. Davids, and recently Schmalensee collected a good series at Andrarum for the United States National Museum. From these collections figures have been drawn that illustrate the appearance of the shells as they occur both in shale and limestone.

The varieties *taconica* and *transversa* are strongly marked, but I think are not entitled to full specific valuation. A direct comparison of specimens from the black shales of Little Metis with those from the black shales of the type locality of *A. sagittalis* at St. Davids fails to disclose any specific differences between them, so far as the material at hand permits of comparison. The Little Metis shell was published as *Linnarssonia* cf. *pretiosa* by Hall [1890, p. 55], and this identification was accepted by Sir William Dawson [1890, p. 53]. "*Obolella pretiosa*" Billings [1862d, p. 68] is a true *Acrothele*, and no species of *Acrotreta* is known to occur at the type locality on the Chaudiere River. The stratigraphic horizon of the Little Metis beds has not been definitely determined. Dawson [1890, p. 32] says: "At Metis the evidence of the pebbles in the conglomerates indicates that they are newer than the Lower Cambrian, and the few fossils found in the sandstones and shales would tend to place them at or on the horizon of the Chazy." I personally examined the section at Little Metis in 1899, and am not at all certain of the horizon of the shales carrying *Acrotreta sagittalis* and the beautiful fossil sponges described by Dawson [1890, pp. 37–55]. It is a region of strong folding and thrust faults. The *Acrothele* is a Middle Cambrian type, and nothing similar to it is known from the Upper Cambrian. As far as this shell can locate the horizon, it is Cambrian, and probably low down in the Upper Cambrian, if not in the Middle Cambrian.

FORMATION AND LOCALITY.—**Passage beds** between the Upper Cambrian and the Ordovician: (**309** [Moberg and Segerberg, 1906, desc. of Pl. 1]) *Ceratopyge* limestone (Zone 4) at Fogelsång, 5 miles (8 km.) east of Lund, Province of Malmöhus, Sweden.

(**323** [Wiman, 1902, p. 66]) *Phyllograptus* slate and *Ceratopyge* limestone in the Christiania region of Norway; and (**323h** [Brögger, 1882, p. 17]) blue *Ceratopyge* limestone at Vestfossen, 10 miles (16.1 km.) west-southwest of Christiania, Norway.

Upper Cambrian: (**321e–321m** [Wiman, 1902, p. 68]) Drift bowlders of *Ceratopyge* slate, Nos. 1–4, 6–8, 9, 12, 14, 17, 23, and 27, on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg; and (**321n** [Wiman, 1902, p. 68]) drift bowlder of limestone (*Ceratopyge* slate horizon), at Trödje, in Gästrikland; both in Sweden.

(**323a** [Wiman, 1902, p. 66]) *Ceratopyge* slate in the Christiania region of Norway.

(**318g** [*Davidson, 1868, p. 310*]) *Lower Lingula flags at Porth-y-rhaw, Pen-y-pleidiau, and several other localities near St. Davids, South Wales.*

(**318c** [Davidson, 1868, p. 310]) Lower *Lingula* flags at the Rheider Waterfall Valley and at Gwynfynydd and other places near Dolgelly, all in North Wales.

Middle? Cambrian (Probably between Middle and Upper Cambrian): (**392g** [Dawson, 1888a, p. 55]) Black shales at Little Metis, Province of Quebec, Canada.

Middle Cambrian: (**2g**) Sandstone of Division 1b1 of Matthew's [1895a, p. 108] *Protolenus* zone on Hanford Brook, St. John County; and (**2s**) limestone in upper part of *Paradoxides* zone, Hastings Cove [Matthew, 1898b, p. 38], on Kennebecasis Bay, 0.5 mile (0.8 km.) northeast of Torryburn, on the Intercolonial Railway northeast of St. John, St. John County; both in New Brunswick.

(**6g**) Limestone near the base of the Middle Cambrian, the lowest horizon carrying *Paradoxides*, northwest side of Chapple Arm Harbor, about 1 mile (1.6 km.) from its head, Trinity Bay; (**6w**) limestone at Seal Point Cove, near Long Point, Trinity Bay; and (**6i**) limestone about 300 feet (91.4 m.) below the base of the Upper Cambrian on shore north of Fosters Point, Random Island, Random Sound; all three in Newfoundland.

(**318h**) Shales in the Menevian at St. Davids, South Wales.

(**316b** [Davidson, 1883, p. 211]) Cairn Burn and Druidhill Burn, both in Dumfriesshire, Scotland.

(**8w**) Limestones of the *Paradoxides forchhammeri* zone, at Andrarum, 20 miles (32.2 km.) northwest of Simrishamn, Province of Christianstad; (**321y**) shale at Andrarum, 20 miles (32.2 km.) northwest of Simrishamn, Christianstad; and (**321z**) shales at Fogelsång, 5 miles (8 km.) east of Lund, Province of Malmöhus; all in Sweden.

(16l) Limestones of the *Paradoxides davidis* zone at Borregaard; (16i) limestones of the *Conocoryphe exsulans* zone at Borregaard; (16j) limestones of the *Paradoxides forchhammeri* zone at Laesaå; (16h and 334h) limestones of the *Paradoxides forchhammeri* zone at Borregaard; and (16k) limestones of the *Paradoxides davidis* zone at Laesaå; all on Bornholm Island, Denmark.

Specimens somewhat doubtfully compared with *Acrotreta sagittalis* occur at the following locality:

Middle Cambrian: (317a [Davidson, 1871, p. 340]) at Bellewstown, County Meath; and at Balbriggan, County Dublin; both in Ireland.

Acrotreta cf. sagittalis.

High up in the Middle Cambrian of the House Range, Utah, there is a small, depressed species of *Acrotreta* that appears to be identical with *A. sagittalis* as the latter occurs in Sweden and Newfoundland. Some of the ventral valves are very low, but specimens of a similar character occur in the limestones of Sweden and Newfoundland.

Formation and locality.—**Middle Cambrian:** (11n) About 3,000 feet (914.4 m.) above the Lower Cambrian and 1,400 feet (426.7 m.) below the Upper Cambrian, in the upper part of the limestone forming 1a of the Marjum limestone [Walcott, 1908f, p. 179], in the long cliff southeast of Marjum Pass [Walcott, 1908f, Pls. XIII and XV], House Range, Millard County, Utah.

A somewhat similar shell that also strongly suggests *Acrotreta sagittalis* occurs in the Middle Cambrian limestones near Antelope Springs, in the House Range, Millard County, Utah. As the material is not very good or abundant, nothing more will be done at present toward identifying it.

Acrotreta sagittalis magna (Matthew).

Plate LXVI, figures 4, 4a–f.

Linnarssonia belti magna Matthew, 1897, Trans. Roy. Soc. Canada for 1897, 2d ser., vol. 3, sec. 4, No. 7, pp. 169–170, Pl. I, figs. 1a–b. (Described and discussed as a new variety. The specimens represented by figs. 1a and 1b are redrawn in this monograph, Pl. LXVI, figs. 4b and 4–4a, respectively.)

Acrotreta sagittalis magna (Matthew), Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 595–596. (Discussed as below.)

In addition to the material collected by Matthew, I have a number of specimens collected by me at the typical locality at Hastings Cove. A comparison with a series of specimens of *Acrotreta sagittalis* (Salter) from St. Davids, Wales, and of *A. sagittalis transversa* (Hartt) shows at once that the form Matthew named is very closely related to both. The length and size of the median ridge, and the position of the central scars of the dorsal valve, and the size and position of the cardinal scars of the ventral valve are the internal characters that Matthew depends upon to distinguish the variety *magna*. All of the characters are fully covered by the variations in the same characters in *A. sagittalis* and its variety *transversa*. The nearly circular form of the variety *magna* is about the only character that can be considered of value, and that is very closely approached by some specimens of *A. sagittalis* (Pl. LXXI, figs. 3b, 3e, 3h).

It is not probable that the New Brunswick shell is a variety of *Acrotreta belti* (Davidson) (Pl. LXXVII). In order to have all the data possible for the student I have illustrated Matthew's types, which he kindly sent me for the purpose, also specimens I found in the limestone at the base of the beds carrying *Paradoxides* at Hanford Brook.

Formation and locality.—**Middle Cambrian:** (2s)[a] *Limestones in upper part of Paradoxides zone, Hastings Cove [Matthew, 1898b, p. 38], on Kennebecasis Bay, 0.5 mile (0.8 km.) northeast of Torryburn, on the Intercolonial Railway, northeast of St. John;* (2i) sandstones of Division 1b3 of Matthew's [1895a, p. 108] *Protolenus* zone, Hanford Brook; and (2l) limestones at base of *Paradoxides* zone, Hanford Brook; all in St. John County, New Brunswick, Canada.

[a] 2s is the type locality, though the specimens in the United States National Museum collections to which that number is assigned were collected later than the type specimens.

Acrotreta sagittalis taconica (Walcott).

Plate LXXI, figures 1, 1a–o.

Linnarssonia taconica Walcott, 1887, Am. Jour. Sci., 3d ser., vol. 34, pp. 189–190, Pl. I, figs. 18, 18a–d. (Described and discussed as a new species. The specimens represented by figs. 18a–c are redrawn in this monograph, Pl. LXXI, figs. 1o, 1c, and 1h, respectively.)

Linnarssonia taconica Walcott, Oehlert, 1889, Annuaire géologique universel for 1888, tome 5, p. 1138. (Described in French in a review of the preceding reference.)

Linnarssonia sagittalis taconica Walcott, 1889, Am. Jour. Sci., 3d ser., vol. 38, p. 36. (Stratigraphic position mentioned.)

Linnarssonia sagittalis taconica Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, pp. 610–611, Pl. LXVIII, figs. 1, 1a–d. (This description and the figures are copied from Walcott, 1887, p. 189, Pl. I, figs. 18, 18a–d.)

Acrotreta sagittalis taconica Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 596–597. (Characterized and discussed as below.)

This variety is characterized by the uniformly shorter median ridge of the dorsal valve. The ventral valve appears to be identical with those of *Acrotreta sagittalis* (Salter) from Andrarum, which are embedded in the same character of matrix as the variety *taconica*.

This is the second representative of the genus found in association with the *Olenellus* fauna. *Acrotreta primæva* Walcott occurs in the upper zone of the *Olenellus* fauna in Nevada, and this is in the upper portion of the same fauna in the Appalachian region. Its association with *Microdiscus connexus*, a representative of *Microdiscus punctatus* of the *Paradoxides* zone of New Brunswick, also serves to connect it with *Acrotreta sagittalis*. It appears to be one of the few forms that connect the Atlantic Province Cambrian fauna with that of the Appalachian Province. It has been found in abundance in the Lower Cambrian of the Canadian Rocky Mountains, thus extending its range to the Cordilleran Province.

Formation and locality.—**Lower Cambrian**: (**36b**) Limestone near schoolhouse No. 12, near Greenwich; (**338g**) limestone in the town of Greenwich; (**33** and **338c**) limestone at and near Rock Hill schoolhouse, near North Greenwich; (**338e**) limestone a little west of North Greenwich; (**338f**) limestone near Argyle, 8 miles (12.8 km.) north of Greenwich; (**36** and **338d**) limestone 1 mile (1.6 km.) south of Shushan; (**338x**) limestone 0.5 mile (0.8 km.) south of Coila, just east of Cambridge; (**43a**) limestone 1 mile (1.6 km.) east-northeast of Salem; (**45a**) limestone at McNaughton Corner, 1 mile (1.6 km.) east of Salem; and (**37b**) limestone 0.25 mile (0.4 km.) east of Salem; all in the Cambridge quadrangle (U. S. Geol. Survey), Washington County, New York.

(**35**) Limestones 1.5 miles (2.4 km.) north of Bald Mountain, 3.5 miles (5.6 km.) north-northwest of Greenwich; and (**338h**) limestone on the summit of Bald Mountain, about 2 miles (3.2 km.) northwest of Greenwich; both in the Schuylerville quadrangle (U. S. Geol. Survey), Washington County, New York.

(**34**) Limestone on roadside a little west of the bridge over Poultney River at Low Hampton, about 5 miles (8 km.) east-northeast of Whitehall; (**39**) limestone south of the Delaware and Hudson Railroad track on the road running south-southwest from Low Hampton, about 5 miles (8 km.) east-northeast of Whitehall; (**45b**) limestone near the roadside about 1,200 feet (366 m.) east of Bristol's house, near Low Hampton, about 5 miles (8 km.) east-northeast of Whitehall; and (**338a**) limestone in the northeast section of Whitehall township; all in the Whitehall quadrangle (U. S. Geol. Survey), Washington County, New York.

(**20a**) Gray limestone, interbedded with shaly slates, in a lane west of Lafayette Stevens's house, about 100 yards (91.4 m.) from the main road, in the southern part of Whitehall township; (**22**) limestone 1.5 miles (2.4 km.) north of North Granville; and (**38a**) *limestone 2 miles (3.2 km.) south of North Granville, on the road which turns south from the road running between that village and Truthville, 4 miles (6.4 km.) west-northwest of Granville;* all in the Fort Ann quadrangle (U. S. Geol. Survey), Washington County, New York.

(**22a**) Limestone in Penrhyn quarries, Middle Granville, Mettawee quadrangle (U. S. Geol. Survey), Washington County, New York.

(**338b**) Limestone on Kinderhook Creek near Stockport Paper Mill; (**29**) limestone just above the bridge at the Stockport Paper Mill, on Kinderhook Creek; (**44b**) limestone near North Chatham; and (**32a**) limestone 0.75 mile (1.2 km.) west of Riders Mills on the Harlem Extension Railroad, about 9 miles (14.4 km.) north-northeast of Chatham; all in the Kinderhook quadrangle (U. S. Geol. Survey), Columbia County, New York.

(**44a**) Limestone on Valatie Kill, near the line between Nassau and Schodack townships, near the line between the Troy and Kinderhook quadrangles (U. S. Geol. Survey); (**338y**) limestone north of Eagle Mills; (**338**) limestone at Schodack, northeast corner of the Coxsackie quadrangle (U. S. Geol. Survey); and (**29a**) limestone 1 mile (1.6 km.) below the New York Central Railroad depot at Schodack; all in Rensselaer County, New York.

(**58k**) Just below the Middle Cambrian in limestones forming 1 of the Mount Whyte formation [Walcott, 1908c, p. 240 (9)]; (**57m**) about 50 feet (15 m.) below the Middle Cambrian in a siliceous shale correlated with 1b of the Mount Whyte formation on Mount Bosworth [Walcott, 1908f, p. 213]; (**57e**) about 115 feet (35 m.) below the Middle Cambrian, in limestone correlated with the top of 1c of the Mount Whyte formation on Mount Bosworth [Walcott, 1908f, p. 213]; (**57r** and **58s**) about 150 feet (46 m.) below the Middle Cambrian, near the base of the limestones forming 3 of the Mount Whyte formation [Walcott, 1908c, p. 241 (10)]; and (**35f**) about 300 feet (91 m.) below the Middle Cambrian, in the limestone forming 6 of the Mount Whyte formation [Walcott, 1908c, p. 242 (11)]; all on Mount Stephen, just above the tunnel on the north shoulder, 3 miles (4.8 km.) east of Field, British Columbia.

(**57s**) About 160 feet (49 m.) below the Middle Cambrian, near the base of the gray oolitic limestone forming 1b of the Mount Whyte formation [Walcott, 1908f, p. 212], on Mount Bosworth, north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide between British Columbia and Alberta, Canada.

Acrotreta sagittalis transversa (Hartt).

Plate LXXII, figures 1, 1a–k.

Obolella transversa Hartt, 1868, Acadian Geology, by Dawson, 2d ed., p. 644. (Characterized.)

Obolella transversa Hartt, 1878, idem, 3d ed., p. 644. (Copy of preceding reference.)

Obolella transversa Hartt, Walcott, 1884, Bull. U. S. Geol. Survey No. 10, p. 16, Pl. I, figs. 5 and 5a. (Original description copied and species discussed. The specimens represented by figs. 5 and 5a are not redrawn in this monograph, but better figures of them are given by Walcott, 1891a, Pl. LXVIII, figs. 2a and 2c, respectively.)

Linnarssonia transversa (Hartt), Walcott, 1885, Am. Jour. Sci., 3d ser., vol. 29, p. 115, figs. 3, 4, 6, and 7, p. 116. (Discussed as the type of the new genus *Linnarssonia*. Figs. 3 and 7 are drawn from the specimens figured by Walcott, 1884a, Pl. I, figs. 5 and 5a, respectively.)

Linnarssonia transversa (Hartt), Matthew, 1886, Trans. Roy. Soc. Canada for 1885, 1st ser., vol. 3, sec. 4, No. 4, p. 35, Pl. V, figs. 11, 11a–e. (Discussed. Casts of the two specimens represented by figs. 11, 11a–e are figured by Walcott, 1891a, Pl. LXVIII, figs. 2d and 2a.)

Obolella transversa Hartt, 1891, Acadian Geology, by Dawson, 4th ed., p. 644. (Copy of Hartt, 1868, p. 644.)

Linnarssonia sagittalis transversa (Hartt), Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, Description of Pl. LXVIII, figs. 2a, 2c, and 2d. (No text reference. Figs. 2a and 2c are drawn from the specimens figured by Walcott, 1884a, Pl. I, figs. 5 and 5a, respectively. Fig. 2d is drawn from the specimen figured by Walcott, 1885a, fig. 6, p. 116. Figs. 2d and 2a are drawn from casts of the two specimens figured by Matthew, 1886, Pl. V, figs. 11, 11a–e.)

Linnarssonia transversa (Hartt), Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, Pl. III, figs. 22 and 23. (Fig. 22 is drawn from the specimen figured by Matthew, 1886, Pl. V, fig. 11.)

Linnarssonia transversa (Hartt), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 108, Pl. III, figs. 38–42. (Mentioned in the text. Figs. 38–39 and 40–42 are drawn from the specimens figured by Matthew, 1886, Pl. V, figs. 11c and 11, respectively. Figs. 42 and 39 are copied from figs. 22 and 23, respectively, of the preceding reference.)

Linnarssonia transversa (Hartt), Matthew, 1895, Trans. New York Acad. Sci. for 1894–95, vol. 14, p. 125, Pl. V, figs. 1a–c and 2a–c. (Locality mentioned. The figures are copied from Matthew, 1886, Pl. V, figs. 11, 11a–e.)

Linnarssonia sagittalis transversa (Hartt), Frech, 1897, Additional plates inserted in 1897 in Lethæa geognostica, pt. 1, Lethæa palæozoica, Atlas, 1876, Pl. 1A, fig. 3b. (No text reference. Fig. 3b is copied from Walcott, 1891a, Pl. LXVIII, fig. 2d.)

This is the representative of *Acrotreta sagittalis* (Salter) in the *Paradoxides* zone of New Brunswick. Many shells are more transverse in outline than the average of *A. sagittalis*, but examples of the latter (Pl. LXXI, figs. 3, 3a, 3g, 3j) are nearly as much so and the interior casts show a striking similarity in the Welsh and Acadian forms. The range of variation in each form is nearly as great as the variation between the two. In view of this, I think it is best to characterize *transversa* as a variety of *A. sagittalis*.

The shells from the "*Protolenus* beds" of Hanford Brook also vary in form from the nearly circular variety *magna* to the transverse forms included under *transversa*.

Formation and locality.—**Upper Cambrian**: (**3**) Shales 300 feet (91.4 m.) above the *Paradoxides* zone, Manuels Brook, Conception Bay, Newfoundland.

Middle Cambrian: (**2f** and **2g**) Sandstones of Division 1b1: (**2h**) overlying 2g in the sandstones of Division 1b2; (**2**) sandstones of Division 1b2; (**2i**) sandstones of Division 1b3; (**2k**) overlying 2i in the sandstones of Division 1b3; and (**301b**) sandstones of Division 1b5 and higher; all in Matthew's [1895a, p. 108] *Protolenus* zone, Hanford Brook, St. John County, New Brunswick.

(**301c**) *Sandstones of the St. John formation, at Coldbrook;* and (**301k**) St. John formation, in the city of St. John; both in St. John County, New Brunswick.

Acrotreta schmalenseei Walcott.

Plate LXX, figures 1, 1a–s.

Not *Acrotreta socialis* von Seebach, 1865, Zeitschr. Deutsch. geol. Gesell. for 1865, Bd. 17, p. 341, Pl. VIIIa, figs. 1–4. (This species is referred in this monograph to *Acrotreta socialis*.)

Acrotreta socialis Linnarsson [not von Seebach], 1876, Bihang till K. svensk. Vet.-Akad. Handl., Bd. 3, No. 12, pp. 16–18, Pl. III, figs. 32–35. (Described and discussed in English.)

?Acrotreta socialis Linnarsson, 1877, Geol. Fören. i Stockholm Förhandl., No. 40, Bd. 3, No. 12, p. 374. (Not figured, and may belong with either *Acrotreta schmalenseei* or *A. socialis*.)

Acrotreta socialis Linnarsson, Wallerius, 1895, Undersökningar öfver Zonen med *Agnostus lævigatus* i Vestergötland, p. 66. (Discussed in Swedish.)

Acrotreta schmalensei Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 597–598. (Described as below as a new species.)

As in the case of many other species of this genus, the student is referred to the series of figures illustrating it for information as to the external outline, form, and convexity of the two valves and the range of known variation. The collections of the United States National Museum contain a large series of specimens from which the shells illustrated were selected.

The broad false area has a shallow, faint median groove on some specimens, and on others no traces of it have been seen. The pedicle aperture, which is exceedingly minute, is situated at the extreme apex of the ventral valve; the cast of the base of the pedicle tube is clearly shown in interior casts of the valve (Pl. LXX, figs. 1f and 1h). One of the distinguishing characters is the cast of the large main vascular sinuses on each side of the visceral area, a feature which varies (Pl. LXX, figs. 1e, 1i, and 1s). The casts of the interior of the dorsal valve (figs. 1j–1p) are interesting and instructive in showing the considerable variation in the size and length of the median ridge, and the size of the cardinal and central scars.

The shell is small and built up of a thin outer layer and several inner layers or lamellæ more or less oblique to the outer layer. The outer surface is marked by fine concentric striæ and lines of growth, and the inner surfaces of the lamellæ by concentric striæ and fine radiating striæ. The average length of the opening of the valves is 1.5 to 2 mm., and the width is usually a little more.

Observations.—All of the specimens illustrated are from the *Paradoxides forchhammeri* zone. They appear to be identical with the figures of *Acrotreta socialis* given by Linnarsson [1876, Pl. III, figs. 32–35], but are not like those given by von Seebach [1865, Pl. VIIIa, figs. 1–4]. Those of the latter represent a shell with strong concentric striæ and median groove on the false area, characters that Linnarsson states that he did not find on his specimens. Among the collections made for me by Mr. G. Schmalensee, a collector in the Geological Survey of Sweden, I find a larger *Acrotreta* than the one described by Linnarsson [1876, p. 16], which agrees with the description of *A. socialis* given by von Seebach [1865, p. 341] and with his figures. Linnarsson writes that he thinks that von Seebach had representatives of several species before him when he wrote his notes on *A. socialis*. With this I fully agree, but with the collections now before me from Bornholm and Oeland, I think the specific name *A. socialis* should be given to the larger shell, illustrated by von Seebach [1865, Pl. VIIIa, figs. 1–4], and a new name given to the smaller and very distinct shell illustrated by Linnarsson [1876, Pl. III, figs. 32–35]. In recognition of the faithful and intelligent work of Mr. G. Schmalensee, I take pleasure in naming the species in his honor.

Acrotreta schmalenseei is of the type of *A. subconica* Kutorga, but is much less elevated. It may be compared with *A. microscopica* (Shumard) and *A. gemma* Billings among American species.

Formation and locality.—**Middle Cambrian**: (**323b**) Limestone of the *Paradoxides ælandicus* zone, at Windjuelandet, Ringsaker, Province of Hedemerken, Norway.

(**320n**) Limestones of the *Paradoxides forchhammeri* zone at Lovened, Djupadal, 19 miles (30.6 km.) south-southeast of Skara; (**320e**) limestone at Munkesten, north of Hunneberg; (**321q**) limestones of the *Paradoxides forchhammeri* zone at Munkesten, north of Hunneberg; and (**320m** [Linnarsson, 1876, p. 18]) limestone of the *Paradoxides forchhammeri* zone at Kinnekulle, northeast of Lidköping; all in the Province of Skaraborg, Sweden.

(**8w**) *Limestones of the Paradoxides forchhammeri zone at Andrarum;* and (**320c** [Wallerius, 1895, p. 66]) Andrarum limestone, at Andrarum; both 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad, Sweden.

(320d) *Exsulans* limestone in the lower part of the *Paradoxides tessini* zone, at Fogelsång, 5 miles (8 km.) east of Lund, Province of Malmöhus, Sweden.

(310c [Wallerius, 1895, p. 66]) Limestone of the *Paradoxides œlandicus* zone, on Oeland Island; (310p [Linnarsson, 1876, p. 18]) limestone of the *Paradoxides œlandicus* zone at Borgholm; and (310b) dark-brown limestone at Borgholm, on Oeland Island; all in Sweden.

(16j) Limestone of the *Paradoxides forchhammeri* zone at Laesaâ; (16h) limestone of the same zone at Borregaard; and (334 [Wallerius, 1895, p. 66]) limestone of the *Paradoxides forchhammeri* zone; all on Bornholm Island, Denmark.

Acrotreta seebachi Walcott.

Plate LXXVII, figures 3, 3a.

Acrotreta seebachi Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 598–599. (Described and discussed as below as a new species.)

Acrotreta seebachi Walcott, Moberg and Segerberg, 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), pp. 66–67. (Characterized and discussed in Swedish.)

Among the fragments of trilobites in the *Ceratopyge* limestone collected by Schmalensee there are a few specimens of a species of *Acrotreta* distinct from *A. schmalenseei* Walcott and *A. socialis* von Seebach. The ventral valve is relatively low, with the false area nearly vertical. A cast of this valve shows the cardinal scars on each side high up toward the apex; small main vascular sinuses and apical callosity. False area rather large and marked by a slight indication of a median depression that is recognized by a slight undulation in the transverse striæ. Surface marked by fine threadlike concentric striæ and lines of growth. A broken dorsal valve has a broad median sulcus and a small distinct beak at the posterior margin. The valves are slightly transverse. A large ventral valve measures 3 mm. in width by 2.5 mm. in length.

The surface striæ and the cardinal scars serve to distinguish this species from others known to me. *Acrothele? ceratopygarum* (Brögger) is from the *Ceratopyge* shales, but it has a low ventral valve with the false area sloping forward.

After deciding that a new species was represented in the material received from Schmalensee, I studied a fine series of specimens that Dr. W. C. Brögger kindly sent me. In material collected by Schmalensee from the *Ceratopyge* shale at Borgholm, Oeland Island, Sweden, some imperfect specimens suggest *Acrotreta seebachi;* they might equally well be referred to *A. carinata* Moberg and Segerberg, or *A. circularis* Moberg and Segerberg.

The specific name was given in honor of Dr. K. von Seebach.

Formation and locality.[a]—**Passage beds** between the Upper Cambrian and the Ordovician: (8x) *Ceratopyge, limestone at Slemmestad, about 3 miles (4.8 km.) southwest of Christiania;* (323d) *Ceratopyge* limestone (Étage 3aγ of Brögger) at Christiania; (323f) lower part of the *Ceratopyge* limestone [Brögger, 1882, pp. 16 and 17] at Vestfossen, 10 miles (16.1 km.) west-southwest of Christiania; (323h) blue *Ceratopyge* limestone [Brögger, 1882, p. 17] at Vestfossen, 10 miles (16.1 km.) west-southwest of Christiania; and (323e) *Ceratopyge* limestone at Engervik, near Christiania; all in Norway.

Upper Cambrian: (310d) *Ceratopyge* slate at Borgholm, Oeland Island, Sweden.

Specimens somewhat doubtfully referred to this species occur at the following locality:

Passage beds between the Upper Cambrian and the Ordovician: (323g) *Ceratopyge* limestone (Étage 3aγ of Brögger), at Vaekkerö, in the Christiania region, Norway.

Acrotreta shantungensis Walcott.

Plate LXIX, figures 5, 5a–e.

Acrotreta shantungensis Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 301–302. (Described and discussed as below as a new species.)

Shell small. Ventral valve a low cone with the apex a little forward of the posterior margin, which is slightly flattened; apex minute, directed backward and projecting slightly over the faintly defined false area. The cast of the interior shows that the apical callosity was rather large and that the main vascular sinuses were well defined on each side of it; the cardinal scars are small and not prominent.

[a] Localities 8x and 310d are represented in the collections of the United States National Museum; the others are in the collection of the University of Christiania.

Dorsal valve slightly convex; apex marginal; surface marked by a rather broad, shallow median depression that begins on the umbo and gradually widens toward the front margin. The interior of the dorsal valve has a strong median ridge extending from the posterior margin two-thirds the distance toward the front. A small, elevated cardinal scar occurs on each side of the median ridge a little in advance of the posterior margin. Main vascular sinuses rather strong; they start beneath the apex and extend forward a short distance from the outer lateral margin of the shell.

Surface marked by fine concentric striæ and lines of growth.

Observations.—This shell in size and general form is closely related to *Acrotreta microscopica* (Shumard) (Pl. LXVII) of the Middle Cambrian fauna of the United States.

The specific name is derived from Shantung, China.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**C37**) Upper part of the Kichou limestone[a] in dense black limestone nodules in green-gray shales 10 feet (3 m.) below the base of the cliff limestone, 8 miles (12.8 km.) south of Tinghianghien; and (**C71**) massive cliff-making limestone in the central portion of the Kichou formation [Willis and Blackwelder, 1907, pp. 139 and 145 (2d list of fossils)], 4 miles (6.4 km.) southwest of Tungyu, Shansi, China.

(**C1**) Lower shale member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 40 (part of the 3d list of fossils), and fig. 10 (bed 4), p. 38], 2 miles (3.2 km.) south of Yenchuang; and (**C62**) *earthy layer in the middle limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 40 (last list of fossils), and fig. 10 (base of bed 7), p. 38], 2.5 miles (4 km.) south of Yenchuang, on the north-northeast spur of Hulushan;* both in the Sintai district, Shantung, China.

A shell apparently identical with *Acrotreta shantungensis* was collected at the following locality:

Middle Cambrian: (**C32**) A fine-grained, bluish-black limestone bowlder believed to have come from the lower part of the Kisinling limestone [Blackwelder, 1907b, p. 272], collected in river drift 1 mile (1.6 km.) south of Chonpinghien, on Nankiang River, southern Shensi, China.

ACROTRETA SIGNALIS Walcott.

Plate LXIX, figure 4.

Acrotreta signalis WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, p. 599. (Described and discussed as below as a new species.)

Ventral valve transverse, broadly ovate; height about one-third the length; apex directed backward on a line with the posterior margin, which is transverse and slightly undulated at the center by the median furrow of the false area; apex with a minute apical foramen which is directed backward. Surface marked by fine concentric striæ and lines of growth that at the median furrow of the false area curve toward the posterior margin.

Shell small, 1.5 mm. long by about 1.75 mm. in width. Shell built up of several very thin layers or lamellæ.

Observations.—In all of the extensive collections made from the Cambrian sandstones of the upper Mississippi Valley, only two ventral valves of any species of *Acrotreta* have been found, as far as known to me. These occur in association with *Lingulella* (*Lingulepis*) *acuminata* (Conrad) and the shells have the color and appearance of those of that species, shiny light gray to white, the original coloring matter having been leached out. Only the exterior of the ventral valve is known. This compared with *A. microscopica* (Shumard) (Pl. LXVII) shows a less elevated ventral valve and a less distinct false area. It also has a marked median groove on the false area. It recalls *A. idahoensis* Walcott, but differs in being more depressed and in having a stronger groove on a narrower false area.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**328e**) "St. Croix sandstone" at St. Croix Falls, Polk County, Wisconsin.

ACROTRETA SOCIALIS von Seebach.

Plate LXXIII, figures 3, 3a–c, 4, 4a–e.

Acrotreta socialis VON SEEBACH [not LINNARSSON], 1865, Zeitschr. Deutsch. geol. Gesell. for 1865, Bd. 17, p. 341, Pl. VIIIa, figs. 1–4. (Described and discussed in German, as a new species. Figs. 1–4 are reproduced in this monograph, Pl. LXXIII, figs. 3, 3a–c, respectively.)

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[a] The fossils from this locality are not listed, but the presence of Cambrian strata at the locality is mentioned by Willis and Blackwelder [1907, p. 146].

Not *Acrotreta socialis* Linnarsson, 1876, Bihang till K. svensk. Vet.-Akad. Handl., Bd. 3, No. 12, pp. 16–18, Pl. III, figs. 32–35. (Described and discussed in English. This species is referred in this monograph to *Acrotreta schmalenseei*.)

?*Acrotreta socialis* Linnarsson, 1877, Geol. Fören. i Stockholm Förhandl., No. 40, Bd. 3, No. 12, p. 374. (Not figured, and may belong with either *Acrotreta socialis* or *Acrotreta schmalenseei*.)

Acrotreta socialis von Seebach, Walcott, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 599–600. (Described and discussed essentially as below.)

Not *Acrotreta* cf. *socialis* Matthew, 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 5, No. 20, pp. 392–394, Pl. XV, figs. 5a–k. (Described and discussed. This species is referred in this monograph to *Acrotreta* sp. undt.)

Not *Acrotreta* cf. *socialis* Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 183–185, Pl. III, figs. 5a–k. (Copy of preceding reference. This species is referred in this monograph to *Acrotreta* sp. undt.)

The species described and illustrated by von Seebach [1865, p. 341, Pl. VIIIa, figs. 1–4] as *Acrotreta socialis* is characterized by a well-marked, concentrically striated surface and a strong median groove in the false area. In the collections made for me by Mr. Schmalensee at Borgholm, Oeland Island, I find associated with *Paradoxides œlandicus* an *Acrotreta* that has these characters. All the specimens from the *Paradoxides forchhammeri* zone in the large collection before me, with the exception of one ventral valve, belong to a distinct species which I have named *A. schmalenseei*. Von Seebach evidently had specimens of the latter species, also of a species of *Acrotreta* from the *Ceratopyge* limestone, as he mentions the occurrence of *A. socialis* at both horizons.

The external form, as far as known to me, is shown by the figures. There is some variation in the height of the ventral valve and in the outline of the margins of the valves. The false area is clearly defined and marked by a strong, rather broad median groove. The pedicle aperture is at the apex of the ventral valve and quite readily seen in several specimens, a character in strong contrast with the minute aperture at the apex of *A. schmalenseei* Walcott. Shell formed of several thin layers or lamellæ that show very plainly where the thin outer layer is exfoliated. Surface marked by striæ and lines of growth that are very distinct on some shells and less so on others; the concentric striæ occur on all the lamellæ of the shell and on the inner surface; fine radiating striæ are to be found on the inner surface. The cast of the interior of the ventral valve shows the presence of a large apical callosity and unusually large pedicle tube and main vascular sinuses on each side of the visceral cavity. The cardinal scars are well defined in both the ventral and dorsal valves. Casts of the interior of the dorsal valve show a strong median ridge, central scars, and fairly well-defined main vascular sinuses. Von Seebach [1865, p. 341] describes the surface as having minute warts on it. I find numerous fragments of the shell of *Acrothele* (*Redlichella*) *granulata* (Linnarsson) associated with *Acrotreta socialis*, and it may be that von Seebach mistook the surface of this shell for that of the species he was describing. No known species of *Acrotreta* has such a surface.

A large ventral valve has a diameter of 5 mm. and a height of 2.5 mm. The average size is about 3 mm. in diameter.

A single ventral valve found by Schmalensee at Andrarum appears to belong to this species. It is a cast of the interior of the shell, and shows concentric ridges or undulations of growth, well-defined cardinal scars, large apical callosity, and short but strong main vascular sinuses (Pl. LXXIII, fig. 4b).

This species belongs to the *A. subconica* Kutorga group of species with a broad false area and well-defined median groove. Its surface is more strongly marked by concentric striæ than any other species of the genus, and the shell is also thicker.

Grönwall [1902, p. 39] and Linnarsson [1877, p. 374] refer specimens to *Acrotreta socialis*, but do not accompany the references by descriptions or figures, and I therefore can not decide whether to include the forms with *Acrotreta socialis* or *Acrotreta schmalenseei*.

Matthew [1902b, p. 392] has compared some imperfect specimens of a species of *Acrotreta* from McNeil Brook, Cape Breton, with *Acrotreta socialis* von Seebach. The shells, as far as can be determined, do not belong to this species. They are about the same size, but the ventral valve is depressed and more like that of *Acrotreta sagittalis magna* (Matthew). I can not identify

the species with the material available for study, and I have entered it in this monograph as *Acrotreta* sp. undt. (see p. 715).

FORMATION AND LOCALITY.—**Middle Cambrian**: (**8z**) Limestones of *Paradoxides œlandicus* zone, Borgholm, Oeland Island; (**320n**) limestones of the *Paradoxides forchhammeri* zone at Lovened, Djupadal, 19 miles (30.6 km.) south-southeast of Skara, Province of Skaraborg; and (**8w**) limestones of *Paradoxides forchhammeri* zone at Andrarum, 20 miles (32.2 km.) northwest of Simrishamn, Province of Christianstad; all in Sweden.

(**334g** [*Seebach, 1865, pp. 340 and 341*]) *Limestones on Bornholm Island, Denmark.*

ACROTRETA SPINOSA Walcott.

Plate LXX1X, figures 4, 4a–g.

Acrotreta spinosa WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 302. (Characterized as below, as a new species.)

The general form of this shell is much like that of *Acrotreta idahoensis* Walcott (Pl. LXVIII, figs. 2, 2a–g). It differs in having a straighter posterior margin. The distinguishing character of the species is the spinose outer surface. The surface is marked by fine concentric lines of growth at irregular intervals, with numerous, very fine, threadlike striæ between. On some shells occur radiating, more or less irregular, fine, rounded ridges that are formed by the elevated elongate spine bases. When these elongate bases are irregularly arranged the radiating ridges are not present. Owing to their minute size, the spinules are rarely seen.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**65**) Limestone on east side of Sierra Canyon, opposite Pinnacle Peak; (**62a**) limestone on east side of Sierra Canyon, opposite the Jackson mine; (**62**) limestone in the Dunderberg shale [Walcott, 1908f, p. 184], in canyon immediately north of Adams Hill; and (**61**) *limestone in the Dunderberg shale [Walcott, 1908f, p. 184], a little south of the Hamburg mine;* all in the Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

ACROTRETA SUBCONICA Kutorga.

Plate LXX111, figures 2, 2a–i.

Acrotreta subconica KUTORGA [not MEEK], 1848, Verhandl. Russ.-kais. min. Gesell. St. Petersburg for 1847, No. 12, p. 275, Pl. VII, figs. 7a–c. (Described in German as a new species; see below for translation. Figs. 7a, 7b, 7c, 7b′, and 7c′ are reproduced in this monograph, Pl. LXXIII, figs. 2, 2a–d, respectively. The specimens represented by figs. 7a, 7b′, and 7c′ are redrawn in this monograph, Pl. LXXIII, figs. 2e, 2h, and 2i, respectively. Figs. 2f and 2g on Pl. LXXIII of this monograph represent one of Kutorga's type specimens, but he figured only the dorsal valve, 1848, Pl. VII, fig. 7c′.)

Acrotreta MORRIS, 1849, Annals and Mag. Nat. Hist., 2d ser., vol. 4, Pl. VII, figs. 4a–b. (No text reference. Figs. 4a and 4b are copied from Kutorga's figures, 1848, Pl. VII, figs. 7b′ and 7c′, respectively, of *Acrotreta subconica*.)

Acrotreta subconica Kutorga, DAVIDSON, 1853, British Fossil Brachiopoda, vol. 1, Introduction, No. 3, Pl. IX, figs. 271–275. (No text reference. Figs. 271–275 are copied from Kutorga, 1848, Pl. VII, figs. 7c, 7a, 7b, 7b′, and 7c′, respectively.)

Acrotreta subconica Kutorga, VON SEEBACH, 1865, Zeitschr. Deutsch. geol. Gesell. for 1865, Bd. 17, p. 341. (Mentioned in discussion of *A. socialis*.)

Not *Acrotreta subconica* MEEK, 1873, Sixth Ann. Rept. U. S. Geol. Survey Territories for 1872, p. 463. (This species is referred in this monograph to *Acrotreta idahoensis*.)

Acrotreta subconica Kutorga, QUENSTEDT, 1885, Handbuch der Petrefactenkunde, Aufl. 3, p. 755, Pl. LVIII, fig. 51. (Mentioned. Fig. 51 is roughly copied from Kutorga, 1848, Pl. VII, fig. 7b.)

Acrotreta subconica Kutorga, WALCOTT, 1902, Proc. U. S. Nat. Mus., vol. 25, pp. 600–601. (Original description translated and type specimens discussed as below.)

The original description by Kutorga follows:

Strongly conical; the deltidium-like furrow narrow and plainly impressed. Innumerable growth wrinkles run on the whole surface of the shell horizontally, and make deflections only in the furrow, the convexity of which is turned toward the base of the cone.

Height of the cone, 0.014; length of the base of the ventral valve, 0.012; breadth of the same, 0.015.

Four specimens, of which one is complete and three are without ventral valve. From the collection of Herr von Volborth.

On one specimen with the apex broken off I investigated the surface of the fracture under the microscope, with a magnification of forty-five times, and found on it two cruriform, shallow impressions similar to those on the casts of the Siphonotretes. Their surface was polished and with impressions of growth folds, and between the extremities of the crura, in the neighborhood of the area-like hinge surface, a columniform fragment of the mold of the siphon. From this it follows that the broken-off tip, just as the beak of the Siphonotretes, was solid and contained a cylindrical siphon.

Observations.—Through the courtesy and permission of Dr. Fr. Schmidt, Dr. Fr. von Huene kindly sent me the types of this species, which he had been studying. One of them preserves the outer shell at the apex. It shows a minute foraminal aperture on the back side of the apex and a strong median groove on the false area. The outlines of the pedicle valve vary from the somewhat diagrammatic drawings of Kutorga [1848, Pl. VII, figs. 7a–c], and there is some variation among the five specimens representing the types. The characters of the shell are shown by the figures on Plate LXXIII.

Formation and locality.—**Ordovician: (336)** *Echinosphærites* limestone, horizon C1a [Fr. Schmidt, personal communication, 1906], Popowka, near St. Petersburg, Russia.

Acrotreta ulrichi Walcott.

Plate LXXVIII, figure 3.

Acrotreta ulrichi Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 96–97, Pl. IX, fig. 3. (Described and discussed as below as a new species. Fig. 3 is copied in this monograph, Pl. LXXVIII, fig. 3.)

This species is founded on a single specimen of a finely preserved ventral valve. The outline of the aperture is nearly circular, except for a short transverse portion beneath the false area; surface moderately convex, with the apex curving and ending beyond the posterior margin so that the minute foraminal aperture opens backward; a small false area is indicated by a slight incurving at the cardinal angles; the area is without traces of a median furrow.

Surface of shell marked by very fine, concentric striæ and lines of growth. Length and width of aperture 2 mm.; convexity of ventral valve 1 mm.

Observations.—This species is characterized by its curved umbo and apex, and overhanging false area. It most nearly resembles *A. curvata* Walcott, from which it differs in being less convex, and in the form of its umbo and curved apex.

The specific name was given in honor of Mr. E. O. Ulrich.

Formation and locality.—**Upper Cambrian: (12p)** About 225 feet (69 m.) above the igneous rocks, in the limestones of the Reagan sandstone, at the northwestern extremity of the Arbuckle Mountains, about 4 miles (6.4 km.) east of Homer, Carter County, Oklahoma.

Acrotreta uplandica Wiman.

Plate LXX, figures 3, 3a–c.

Acrotreta uplandica Wiman, 1902, Bull. Geol. Inst. Univ. Upsala, vol. 6, pt. 1, No. 11, p. 54, Pl. II, figs. 15–18. (Described in German as a new species. The specimens represented by figs. 15–18 are redrawn in this monograph, Pl. LXX, figs. 3, 3a–c, respectively.)

Acrotreta uplandensis (Wiman), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 302. (Characterized as below.)

This species recalls at once *Acrotreta idahoensis sulcata* Walcott. It differs from it in having a broader false area. The surface is marked by fine, threadlike striæ that cross the false area and false pedicle groove.

Formation and locality.—**Middle? Cambrian: (311b)** *Drift bowlder of gray bituminous sandstone, No. 2 [Wiman, 1902, p. 57], on Biludden, about 20 miles (32.2 km.) east of Gefle, Province of Gefleborg;* and **(311p)** drift bowlder of glauconitic sandstone, No. 1 [Wiman, 1902, p. 57], at Höganäs, parish of Börstil, east of Östhammar, Province of Stockholm; both in Sweden.

Acrotreta uplandica limöensis (Wiman).

Plate LXX, figures 4, 4a–c.

Acrotreta limöensis Wiman, 1902, Bull. Geol. Inst. Univ. Upsala, vol. 6, pt. 1, No. 11, p. 54, Pl. II, figs. 19–22. (Characterized in German as a new species. The specimens represented by figs. 19–22 are redrawn in this monograph, Pl. LXX, figs. 4, 4a–c, respectively.)

Acrotreta uplandica limonensis (Wiman); Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 303. (Characterized as on p. 715.)

Wiman states [1902, p. 54] that this form is quite like *Acrotreta uplandica*, but lower, as the height is only one-third of the diameter. It is so close in all other respects that I do not think that more than a varietal value should be given to the differences mentioned.

The specific name is derived from Limön Island, Sweden.

FORMATION AND LOCALITY.—**Middle? Cambrian:** (311n) Drift bowlder of bluish calcareous sandstone, No. 6 [Wiman, 1902, p. 57], on Limön Island, about 12 miles (19.3 km.) east-northeast of Gefle, Province of Gefleborg, Sweden.

ACROTRETA sp. undt.

Acrotreta cf. *socialis* MATTHEW [not LINNARSSON or VON SEEBACH], 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 5, No. 20, pp. 392–394, Pl. XV, figs. 5a–k. (Described and discussed.)

Acrotreta cf. *socialis* MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 183–185, Pl. III, figs. 5a–k. (Copy of preceding reference.)

Matthew describes and illustrates this form and compares it with *Acrotreta socialis* von Seebach. A comparison of his specimens with *A. socialis* shows the two forms to be distinct. Matthew's specimens are more suggestive of *A. sagittalis magna* (Matthew) (Pl. LXVI, figs. 4, 4a–f) except that the ventral valve is higher.

With the original specimens for study it appears best to indicate this form as an undetermined species.

FORMATION AND LOCALITY.—**Middle Cambrian:** (325a [Matthew, 1903, p. 184]) Shales of Division C2c of Matthew's Bretonian, on the eastern slope of the valley of McNeil Brook, on the road to Trout Brook, Cape Breton, Nova Scotia.

ACROTRETA sp. undt. Westergård.

Acrotreta sp. WESTERGÅRD, 1909, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 4 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 20), pp. 57 and 77, Pl. II, figs. 25a–b. (Locality mentioned in Swedish.)

This species is not described by Westergård, and I have not seen the specimen. It is of medium height and appears to be a true *Acrotreta*.

FORMATION AND LOCALITY.—**Upper Cambrian:** (310t) *Subzone c of the Dictyograptus slate at Fogelsång;* (310u) subzone *c* of the *Dictyograptus* slate at Jerrestad; and (310v) subzone *b* of the *Dictyograptus* slate at Tosterup; all Westergård, 1909, pp. 57 and 77] in the Province of Malmöhus, Sweden.

Genus ACROTHYRA Matthew.[a]

[ἄκρος, at the top; and θύρα, a door.]

Acrothyra MATTHEW, 1901, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 4, No. 19, pp. 303–304. (Described and discussed as a new genus.)

Acrothyra MATTHEW, 1902, Trans. Roy. Soc. Canada for 1902, 2d ser., vol. 8, sec. 4, No. 3, p. 104. (Notes on variation in size, etc., of the different species and varieties of *Acrothyra*.)

Acrothyra MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 85–86. (Copied from Matthew, 1901b, pp. 303–304.)

Acrothyra MATTHEW, 1903, idem, pp. 88–89. (Copied from Matthew, 1901b, p. 304.)

Acrothyra Matthew, WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 146. (Classification of genus.)

Ventral valve elongate conical, with the posterior face more or less flattened to form a false area marked on the median line by a shallow groove. Area unknown. The slope of the false area is usually backward so as to throw the apex back of the posterior margin, but in some instances it is directly on a line with the margin. Pedicle opening minute, slightly truncating the apex. Dorsal valve strongly convex with the beak marginal. Area unknown.

Surface marked by fine, concentric striæ and lines of growth and very fine, irregular, concentric striæ that inosculate so as to give a granulose or pitted surface when seen by a strong lens. The inner surface of the ventral valve shows fine radiating lines in some specimens. The shell is built up of several thin layers or lamellæ of a calcareocorneous character. The

[a] The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Acrothyra* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed: *Acrotreta* Matthew [1899b, p. 203; 1902b, pp. 390 and 391; 1903, pp. 73 and 95].

dorsal valve is usually thicker than the ventral valve, and its inner lamellæ are arranged more oblique to the outer layer.

The cast of the ventral valve indicates a small apical callosity penetrated by a slender pedicle tube. The main vascular sinuses are almost straight from the apex far out toward the anterolateral portion of the valve; in the short valves they diverge quite rapidly, but in the elongated valves they leave but a narrow space for the visceral area. From the anterior margin of the apical callosity two narrow ridges extend well forward and then curve outward and inward to meet about a central depression or pit that occupies the same relative position as the central depression of the visceral cavity in *Obolus* and its subgenera. The cardinal scars have not been observed. The interior of the dorsal valve is strongly concave. A slight median ridge is seen in some specimens and in others it is very difficult to determine its presence except in the posterior third of the shell, where it is often very strong. On each side of the median ridge there is usually a rather deep groove in which, at about one-third the distance from the posterior to the front margins of the valve, the central muscle scars occur; the cardinal scars are clearly defined on each side of the median ridge near the posterior margin.

Type.—*Acrotreta proavia* Matthew.

Observations.—This genus is intimately related to *Acrotreta* and except for the presence in some species of a well-marked visceral area of a type not known in *Acrotreta* there would be difficulty in assigning more than a subgeneric value to it. Matthew [1901b, p. 303] considers that the mode of occurrence of the ventral valve indicates a difference from *Acrotreta*, but in the large collection made by Loper the ventral valve of *Acrothyra* lies on the long side of the cone, the aperture being up; this is the position the shell would take in settling down on the bottom when the animal was out of the shell and the dorsal valve detached. I have found hundreds of specimens of the ventral valve of *Acrotreta idahoensis* Walcott and *A. attenuata* Meek lying on the upper surface of layers of limestone in situ, in just the same positions as those taken by *Acrothyra proavia* (Matthew).

Four species of the genus are known to me: *Acrothyra proavia* (Matthew), *A. signata* Matthew, *A. sera* (Matthew), and *A. minor* Walcott. Matthew [1902a, pp. 381–390] has described a number of varieties of the two Acadian species. In the case of the varieties of *A. proavia* I find that there is such a gradation of form and character between the varieties that they are of little value. In *A. signata* the varieties *prima* and *orta* are apparently distinctive.

After a thorough comparison of Matthew's types of *Acrothyra signata sera*, *Acrothyra signata tarda*, *Acrotreta papillata* and varieties *prima* and *lata*, and a large series of specimens from the same locality and stratigraphic horizon, I have identified the four forms as *Acrothyra sera*. There is such a gradation in size and shape of the visceral area and exterior of the ventral valve that it does not appear practicable to draw lines establishing varieties and species. The gradation of characters between Matthew's *Acrothyra signata sera* and his *Acrotreta papillata* also practically brings together *Acrothyra* and *Acrotreta*. An attempt is made on Plate LXXX to show some of the gradations in the form of the visceral area (figs. 6d, 6e, 5a, 6f, 6g, 6h, and 6a).

Matthew [1902a, p. 381] assigns importance to the stratigraphic position of the specimens he has referred to species and varieties. This does not appear to hold good in the large collections made by Loper. Most of the varieties in form and robustness occur at the horizon of *Acrothyra sera* and those assigned to *A. proavia* at its horizon. This makes it difficult to give the same importance to the variations that Matthew [1902a, pp. 381–390] does in his descriptions. The latter are presented in great detail and should be consulted by those interested in this genus or in the Acrotretidæ.

Matthew [1901c, pp. 93–107] has made some most interesting and suggestive observations on the resemblance of the more elongated forms of *Acrothyra* to some species of *Hyolithes*, suggestions to which the student of the Brachiopoda should give careful consideration.

Acrothyra minor Walcott.

Text figure 59; Plate LXXVI, figures 4, 4a–b.

Acrothyra minor Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 303. (Characterized as below as a new species.)

This species differs from others referred to the genus by its broad form and very strong vascular sinuses. The elevated callus between the sinuses is high and oval in outline, somewhat like that of *Acrotreta inflata* (Matthew). It may be that this species belongs to a different genus, but with the material available for study it is referred to *Acrothyra* on account of its low overhanging false area and elongate visceral area.

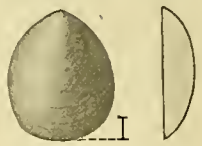

FIGURE 59.—*Acrothyra minor* Walcott. A, A', Exterior and side views of a ventral valve from Locality 54s, about 2 miles (3.2 km.) southeast of Malade, Idaho (U. S. Nat. Mus. Cat. No. 52051).

FORMATION AND LOCALITY.—**Middle Cambrian:** (**5b** and **54s**)[a] Dark blue-gray Langston limestone [Walcott, 1908f, p. 198], just above the Cambrian quartzitic sandstones, north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

Acrothyra proavia (Matthew).

Plate LXXV, figure 3; Plate LXXVI, figures 3, 3a–u.

Acrotreta proavia Matthew, 1899. Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 3, No. 19, p. 203, Pl. III, figs. 2a–f. (Described and discussed as a new species.)

Acrothyra proavia prima Matthew, 1901, idem, vol. 4, pt. 4, No. 19, figs. 1–6, p. 303. (No mention of this species is made in the text, which is a description of the genus *Acrothyra*, but the variety is figured for the first time. The specimen represented by fig. 1 is redrawn in this monograph, Pl. LXXVI, fig. 3.)

Acrothyra proavia Matthew, 1902, idem, vol. 4, pt. 5, No. 20, pp. 386–388, Pl. XIV, figs. 2a–g and 3a–f. (Described and discussed. Figs. 2a–f are copied from Matthew, 1899, Pl. III, figs. 2a–f.)

Acrothyra proavia prima Matthew, 1902, idem, p. 389, Pl. XIV, figs. 4a–f. (Described. Figs. 4a–f are copied from Matthew, 1901b, figs. 1–6, p. 303.)

Acrothyra proavia crassa Matthew, 1902, idem, pp. 389–390, Pl. XIV, figs. 5a–c. (Described and discussed as a new variety.)

Acrothyra proavia Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 53–55, 57, and 59. (Notes on orientation of shells.)

Acrothyra proavia prima Matthew, 1903, idem, p. 58. (Notes on orientation of shells.)

Acrothyra proavia prima Matthew, 1903, idem, figs. 1–6, p. 86. (Figs. 1–6 are copied from Matthew, 1901b, figs. 1–6, p. 303.)

Acrothyra proavia prima Matthew, 1903, idem, p. 93, Pl. II, figs. 4a–f. (Text and figures copied from Matthew, 1902a, p. 389, Pl. XIV, figs. 4a–f.)

Acrothyra proavia crassa Matthew, 1903, idem, p. 94, Pl. II, figs. 5a–c. (Text and figures copied from Matthew, 1902a, pp. 389–390, Pl. XIV, figs. 5a–c.)

The generic description is founded on this species and gives all of its principal characters. Matthew refers to several varieties of this species and [1901b, p. 303, and 1902a, p. 389] names two of them, *prima* and *crassa*. Loper's collection shows a great variation in the form and outline of the valves, particularly the ventral, that appears to include the varieties described by Matthew. The typical form of *A. proavia* is illustrated by Plate LXXVI, figures 3a, 3b, and 3c; the variety *prima* by figure 3, and the variety *crassa* by figures 3e and 3f. The gradations in form between the typical form and its varieties may be traced by the figures on the plate, and by a study of the large series of specimens in the collections.

The height of the posterior side or false area has been found one-third, one-half, and about three-fifths of the length of the anterior slope from the apex to the margin. The wide variation appears to be due very largely to compression and distortion in the sediment.

Acrotreta gemmula Matthew occurs in association with this species, and this leads to confusion of the dorsal valves of the two species unless care be taken to distinguish them. The *A. gemmula* shells are rare, and the shell is thinner, which gives less strongly marked interiors, and less convexity to the outer surface. The dorsal valve of *Acrothyra proavia* is convex, strong, and deeply marked by the grooves made by the main vascular sinuses.

[a] 5b is the type locality.

Acrothyra proavia differs from *A. signata* Matthew, which occurs about 200 feet lower in the strata of the same section, in having usually a narrower, more elongate visceral cavity, and stronger callosity. These features, however, vary in specimens of *A. proavia* associated in the same hand specimen of shale.

Formation and locality.—**Middle Cambrian:** (**3i**) Compact, fine-grained, thin-bedded gray sandstone of the *Paradoxides* zone, on McLean Brook, 1 mile (1.6 km.) east of McCodrum Brook and 1.5 miles (2.4 km.) west of Marion Bridge; (**13m**) sandstones of Division E3f of Matthew's [1903, p. 76] Etcheminian, on Gillis Brook, Indian River; and (**344j** [Matthew, 1903, p. 91]) Division E3e of Matthew's Etcheminian, on the highway at V. McPhees; all in eastern Cape Breton, Nova Scotia.

(**10p**) Sandstone just below the waterfall in Dugald Brook, Division E2b; (**10q**) sandstones a little above 10p in Division E2b; (**13e**) sandstones of Division E2c; (**131** and **344i** [Matthew, 1903, p. 80]) sandy shales of Division E3a; (**13n″** and **344b** [Matthew, 1903, p. 91]) sandstones of Division E3d; (**13n′**) sandstones of Division E3e; (**344a** [*Matthew, 1902b, p. 422*]) *sandy shales of Division E3c;* and (**344d** [Matthew, 1903, p. 82]) sandy shales of Division E3f; all in Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

Acrothyra sera (Matthew).

Plate LXXX, figures 4, 4a–c, 5, 5a–d, 6, 6a–i, 7, 7a–b, 8?.

Acrothyra (*signata*) *sera* Matthew, 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 5, No. 20, pp. 383–384, Pl. XIII, figs. 3a–f. (Described and discussed as a new variety. The specimen represented by fig. 3c is redrawn in this monograph, Pl. LXXX, fig. 4c.)

Acrothyra signata-tarda Matthew, 1902, idem, pp. 384–385, Pl. XIV, figs. 1a–d. (Described and discussed as a new variety.)

Acrotreta papillata Matthew, 1902, idem, pp. 390–391, Pl. XV, figs. 2a–f. (Described as a new species. In the description of Pl. XV the legend for figs. 1a–c appears as the legend for figs. 2a–c, and the legend for figs. 2a–f as the legend for figs. 1a–f; the specimens represented by figs. 1a–c (on the plate) are referred to *Acrotreta papillata prima;* and the specimens represented by figs. 2a–f (on the plate) are referred to *Acrotreta papillata.* The description of plate is in error, the correct reference being as given in this synonymy. The specimen represented by figs. 2a and 2b is redrawn in this monograph, Pl. LXXX, figs. 6 and 6′.

Acrotreta papillata var. Matthew, 1902, idem, p. 391, Pl. XV, figs. 3a–c. (Described. The varietal name *lata* is given to this form in the description of Pl. XV.)

Acrotreta papellata-prima Matthew, 1902, idem, pp. 391–392, Pl. XV, figs. 1a–c. (Described and discussed as a new variety. The third reference explains error in description of plate.)

Acrothyra signata sera Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 56. (Notes on the orientation of the shells.)

Acrotreta papillata-prima Matthew, 1903, idem, pp. 73–74, Pl. III, figs. 1a–c. (Mentioned as a new variety, but copies the original text and figures, Matthew, 1902a, pp. 391–392, Pl. XV, figs. 1a–c. The same error occurs in the description of Pl. III as occurred in the description of Pl. XV; see the third reference.)

Acrothyra signata sera Matthew, 1903, idem, pp. 87–88, Pl. I, figs. 3a–f. (Text and figures copied from Matthew, 1902a, pp. 383–384, Pl. XIII, figs. 3a–f.)

Acrothyra signata-tarda Matthew, 1903, idem, p. 89, Pl. II, figs. 1a–d. (Text and figures copied from Matthew, 1902a, pp. 384–385, Pl. XIV, figs. 1a–d.)

Acrotreta papillata Matthew, 1903, idem, p. 95, Pl. III, figs. 2a–f. (Text and figures copied from Matthew, 1902a, pp. 390–391, Pl. XV, figs. 2a–f. The same error occurs in the description of Pl. III as occurred in the description of Pl. XV; see the third reference.)

Acrotreta papillata lata Matthew, 1903, idem, pp. 95–96, Pl. III, figs. 3a–c. (Text and figures copied from Matthew, 1902a, p. 391, Pl. XV, figs. 3a–c.)

Acrothyra sera differs from *A. signata* in the form of the visceral area and callosity, straighter and nearly vertical posterior side. It is usually more elongate. Matthew [1902a, p. 383] placed it as a variety of *A. signata,* but its characters appear to justify giving it the rank of a species.

A gradation in length, breadth, depth, and outline of the ventral valve and its visceral area is found in specimens from the same bed of rock, that bring together *Acrothyra signata sera* and *tarda* and *Acrotreta papillata* and its varieties *lata* and *prima.* Matthew [1902a, pp. 383–385, 390–392] based the above-mentioned species and varieties on differences in form of the ventral valve and its visceral cavity and callosity. With his type specimens before me, and the large series of specimens collected by Loper from Matthew's Division 1, assise d, and from Division 2, between assise a and b, it is impossible for me to consider that more than one variable species is represented. As the name *sera* is first in order in the original publication, it is retained for the species. Also see notes under genus *Acrothyra,* pages 715–716.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**10p′**) Sandstone 0.25 mile (0.4 km.) from the lower bridge on Gregwa Brook, Indian River; (**10p″**) sandstone on the small brook on the hill between the bridge over Indian River and McPhees Brook; (**13k**) shales of Matthew's [1903, p. 15] Coldbrook, above the great fall in Dugald Brook, Indian River; and (**344e** [Matthew, 1903, p. 78]) shales of Division E1d of Matthew's [1903, pp. 28 and 29] Etcheminian, on Boundary Brook, eastern side of the Escasonie Indian Reservation; all in eastern Cape Breton.

(**344g** [*Matthew, 1903, p. 77*]) *Shales of Division E1c;* (**13t″**) sandstones of Divisions E1c and E1d; (**13f**) sandstones 20 feet (6 m.) above Division E2a; (**13d′**) sandstones opposite the third waterfall in Dugald Brook, between Divisions E2a and E2b; (**10p**) sandstones just below the waterfall in Division E2b; and (**13e**) sandstones of Division E2c; all in Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

Shells somewhat doubtfully referred to *Acrothyra sera* occur at the following localities:

Middle Cambrian: (**13p**) Sandstones 40 feet (12.2 m.) above Division E2a; and (**13p′**) sandstones 45 feet (13.6 m.) above Division E2a; both in Matthew's [1903, p. 21] Etcheminian, on Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

ACROTHYRA SIGNATA Matthew.

Plate LXXX, figures 1, 1a–d.

Acrothyra signata MATTHEW, 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 5, No. 20, pp. 381–382, Pl. XIII, figs. 2a–e. (Described and discussed as a new species, see below for copy of the greater part. The specimens represented by figs. 2b and 2c are redrawn in this monograph, Pl. LXXX, figs. 1 and 1d, respectively.)

Acrothyra signata MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 87, Pl. I, figs. 2a–e. (Text and figures copied from preceding reference.)

Matthew's description [1902a, p. 381] of the interior of the two valves is as follows:

There is a strong narrow callus, one-third of the length of the valve, bounded by a raised ridge at the sides and in front; at the front of this callus is an oval pit, from which a groove runs backward nearly to the apex of the shell, where it is supposed to connect with the foramen. Outside the callus, on each side, near the margin of the valve, are lenticular marks of the lateral muscles. About the middle of the valve the position of the anterior adductors is indicated by a faint impression of the lozenge or "heart-shaped" depression. * * *

* * * This shows a sharp, thin, median septum for half of the length of the valve. This ridge is broader and more distinct at the front; at each side are lateral obscure ridges, diverging from the umbo. Outside of these ridges are the lenticular imprints of the lateral muscles.

The only modification to be made is in leaving out the word "narrow" before "callus" in the description of the ventral valve. The callosity is strong and relatively broad.

Among the type specimens received from Doctor Matthew one ventral valve is elongate, like the type figured by him. Two other ventral valves are shorter, like our figures 1, 1a–b. The dorsal valves are similar in the material received from Doctor Matthew and that illustrated by him, and in the collection made by Mr. S. Ward Loper.

A. signata differs from *A. proavia* (Matthew) in the less elongate, narrow visceral cavity and apical callosity of the ventral valve. It occurs at about 200 feet lower in the strata, according to Matthew, who [1903, pp. 23–27] gives a detailed section of the beds and lists of fossils occurring at each faunal zone.

Matthew [1902a, p. 382] found this species in his Division E1b. Loper collected it from Matthew's Division E1d; also in abundance between Divisions E2a and E2b on Dugald Brook.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**13t**) Sandstones at the base of Division E1b; (**344k** [*Matthew, 1903, p. 77*]) *sandstones of Division E1b;* (**13t″**) sandstones of Divisions E1c and E1d; (**13d′**) sandstones opposite the third waterfall in Dugald Brook, between Divisions E2a and E2b; (**10p**) sandstones just below the waterfall in Division E2b; all in Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

ACROTHYRA SIGNATA ORTA Matthew.

Plate LXXX, figures 3, 3a–b.

Acrothyra signata orta MATTHEW, 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 5, No. 20, pp. 385–386, Pl. XIII, figs. 4a–f. (Described and discussed as a new variety. The specimens represented by figs. 4a and 4c are redrawn in this monograph, Pl. LXXX, figs. 3a and 3b, respectively.)

Acrothyra signata orta MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 89–90, Pl. I, figs. 4a–f. (Text and figures copied from the preceding reference.)

A. signata orta differs from *A. signata* Matthew in its more elongate form and narrow visceral area, characters that place the variety near *A. proavia* (Matthew). Its shorter visceral area distinguishes it from *A. proavia.* In the absence of specimens showing the interior of the ventral valve there is no way of distinguishing *A. proavia* from *A. signata orta.*

FORMATION AND LOCALITY.—**Middle Cambrian**: (**13d″**) Sandstones 10 feet (3 m.) below Division E2a; (**10p**) sandstones just below the waterfall in Division E2b; and (**3441** [*Matthew, 1903, p. 90*]) *sandstones of Division E2c;* all in Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.

ACROTHYRA SIGNATA PRIMA Matthew.

Plate LXXX, figures 2, 2a–b.

Acrothyra signata prima MATTHEW, 1902, Bull. Nat. Hist. Soc. New Brunswick, vol. 4, pt. 5, No. 20, pp. 382–383, Pl. XIII, figs. 1a–g. (Described and discussed as a new variety. The specimens represented by figs. 1b and 1c are redrawn in this monograph, Pl. LXXX, figs. 2 and 2b, respectively.)

Acrothyra signata prima MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 73, Pl. I, figs. 1a–g. (Text and figures copied from the preceding reference.)

The material representing this shell is in poor condition, but sufficient evidence of the form and interior characters of the ventral valve is preserved to show that it differs from *A. signata* Matthew in its subconical form, and in the shorter and proportionally broader visceral area. It is very difficult to find any clearly defined distinction between some specimens of *Acrothyra sera* Matthew and *A. signata prima*, as the latter shows ventral valves quite as regularly conical as the former. One of Matthew's type specimens shows a much higher apex on the ventral valve than his figure 3c [1903, Pl. I]; another with the apex broken off shows a cast of the visceral cavity much like that in Plate LXXX, figure 1a (*A. signata* Matthew).

Matthew [1902a, p. 383] found the types of this species in a fine gray shale interbedded in the volcanic beds. The associated fossils clearly indicate that the fauna is essentially the same as that which follows higher in the strata.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**13k**) [a] Shales of Matthew's [1903, p. 15] Coldbrook, above the great waterfall in Dugald Brook, Indian River, Cape Breton, Nova Scotia.

Genus DISCINOPSIS Matthew.[b]

[δίσκος, quoit; and ὤψ, face.]

Discinopsis (MATTHEW MS.) HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, pp. 250–251. (Described.)

Discinopsis Matthew, HALL and CLARKE, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, pp. 566–567. (Copy of preceding reference.)

Discinopsis Matthew, HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 105–106. (Described and discussed as a new genus.)

Discinopsis Matthew, WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 146. (Classification of genus.)

All that is known of this genus is incorporated under the description of the type species.

Type.—Acrotreta? gulielmi Matthew.

DISCINOPSIS GULIELMI (Matthew).

Plate LXXXII, figures 5, 5a–c.

Acrotreta? gulielmi MATTHEW, 1886, Trans. Roy. Soc. Canada for 1885, 1st ser., vol. 3, sec. 4, No. 4, pp. 37–39, Pl. V, figs. 14, 14a–e. (Described and discussed as a new species; see below for copy. The specimen represented by figs. 14c and 14d is redrawn in this monograph, Pl. LXXXII, fig. 5. Figs. 5a–c of this monograph are drawn from specimens in the type material, but none of them can be identified with Matthew's figures.)

Discinopsis gulielmi (Matthew), HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, Pl. III, figs. 20 and 21. (Fig. 20 is drawn from the specimen figured by Matthew, 1886, Pl. V, figs. 14c and 14d. Fig. 21 is drawn from one of Matthew's type specimens, and the same specimen is redrawn in this monograph, Pl. LXXXII, fig. 5a, but the specimen can not be identified with any of Matthew's figures.)

Discinopsis gulielmi (Matthew), HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 105, Pl. III, figs. 20–24. (Discussed. Figs. 20 and 21 are copied from figs. 20 and 21 of the preceding reference. The remaining figures are drawn from specimens in Matthew's type material. Figs. 21, 22, and 23 represent specimens which are redrawn in this monograph, Pl. LXXXII, figs. 5a (=21 and 22) and 5c (=23), but it is impossible to identify the specimens with Matthew's figures.)

The original description by Matthew follows:

Shell subcircular in outline. Surface depressed-conical, apices eccentric, not marginal. Pedicle valve with the apex truncated by a circular foraminal aperture (?). The interior of this valve is characterized by a pair of deep,

[a] **13k** is the type locality, though the specimens represented by that number in the United States National Museum collections were collected later than the type specimens.

[b] Prior to the definition of the genus *Discinopsis* the type species was referred to *Acrotreta?* [Matthew, 1886, p. 37].

diverging furrows, passing forward from the beak or internal foraminal opening, in broad curves which converge toward the anterior margin but without meeting. These furrows inclose a thickened and somewhat elevated central area, which, in the subumbonal region, is apparently free, projecting for a short distance, like a narrow, triangular shelf, beneath which the foramen probably opened. The interior opening of the foramen is, however, not apparent on any of the specimens examined, for, as usually preserved, the matrix has adhered to this subapical cavity, and in a single example only is the shelf-like character of the median area distinctly demonstrated. A faint longitudinal ridge passes from the apex of the shelf to the anterior margin, but no other markings are discernible on the interior except faint radiating or slightly undulating, probably vascular lines.

The interior of the brachial valve, as far as known, shows no other characters than the radiating lines, which appear to belong to the ornamentation of the outer surface.

Shell substance tenuous, apparently corneous. External surface covered with more or less prominent, sometimes lamellose concentric growth lines, crossed by fine, gently curved, radiating striæ which are usually more prominent when the concentric lines are exfoliated.

Observations.—The interior of the ventral valve of this species is not unlike that of *Acrothele*. (Compare Pl. LXXXII, fig. 5a, with Pl. LX, figs. 1f and 2.) It is not like that of *Acrotreta sagittalis taconica* (Pl. LXXI). I have not been able to find an apical shelf in the type specimens or other specimens. The material representing *D. gulielmi* is compressed in the shale, so that the apical callosity is more or less compressed and distorted. The dorsal valve, with its eccentric apex, is unlike *Acrothele* or any other of the genera of the Acrotretidæ.

With our present information, *Discinopsis* is referred to the Acrotretidæ and nearest to *Acrothyra*.

I have not discussed the description and conclusions of Matthew [1886, p. 37], as neither Hall and Clarke nor I could find the muscle scars described and illustrated by him. The student should carefully read Matthew's description and observations, as there is much opportunity for difference of opinion of minute shells compressed in shale.

Formation and locality.—**Middle Cambrian**: (**301g** [*Matthew, 1886, p. 39*]) *Sandstones of Division 1c of Matthew;* (**308h**) shales of Division 1c1; and (**301w**) shales of Division 1c2; all at Portland (now part of the city of St. John), St. John County, New Brunswick.

Discinopsis? sulcatus Walcott.

Plate LXXXII, figure 6.

Craniella?? sp., Walcott, 1905, Proc. U. S. Nat. Mus., vol. 29, pp. 4 and 6. (Listed.)
Discinopsis sulcatus Walcott, 1906, idem, vol. 30, pp. 568–569. (Described and discussed as below as a new species.)

This species is based upon the cast of the interior of a small ventral valve that in its interior markings closely approaches the interior of the ventral valve of *Discinopsis gulielmi* (Matthew).

The interior cast shows that the ventral valve was subcircular in outline, moderately convex, and with the apex probably perforated by a small, circular, foraminal aperture. In front of the cast of the base of the foraminal aperture there is a broad depression that extends to the front margin; on each side of the central depression an elongate, slightly depressed area extends forward and outward from near the base of the cast of the foraminal aperture, along the ridge on each side of the median depression; back of the base of the foraminal aperture there is a narrow, short, arched furrow that indicates the presence of a corresponding ridge on the interior of the shell. No other markings are shown on the cast, except the faint outline of what may have been the visceral area, on the median line in front of the base of the foraminal aperture and between the broad vascular sinuses.

Observations.—This species is referred to the genus *Discinopsis* as the result of comparison with specimens of the interior of a ventral valve of *D. gulielmi* (Matthew). One interior of the latter species has scars much like those shown in *D.? sulcatus*.

This form has a sulcate ventral valve, hence the specific name.

Formation and locality.—**Upper Cambrian**: (**C56**) Lower part of the Chaumitien limestone, 25 feet below the top of Pagoda Hill [Blackwelder, 1907a, p. 42 (part of last list of fossils)], 1 mile (1.6 km.) west of Tsinan, Shantung, China.

Superfamily DISCINACEA Waagen.

Family DISCINIDÆ Gray.

Genus ORBICULOIDEA d'Orbigny.

For synonymy, description, and discussion of this genus the student is referred to the memoir of Hall and Clarke [1892c, pp. 120–137]. The genus has been recently classified [Walcott, 1908e, Pl. XI, and pp. 142 and 147].

Two Upper Cambrian species are tentatively referred to the genus: *O. varians* (Barrande) and *O. contraria* (Barrande), and one Middle Cambrian species, *O. pileolus* (Salter).

Orbiculoidea contraria (Barrande).

Plate LXXXI, figure 9.

Discina contraria Barrande, 1868, Faune silurienne des environs de Hof, en Bavière, p. 104, fig. 72. (Described in French as a new species; see below for translation. Fig. 72 is copied in this monograph, Pl. LXXXI, fig. 9.)

Genre? sp. *nebulosa* Barrande, 1868, idem, pp. 105–106, fig. 69. (Described and discussed in French as a new species.)

Discina contraria Barrande, 1868, Neues Jahrb. für Mineralogie for 1868, pp. 692–693, unnumbered plate, fig. 72. (Copied from Barrande, 1868a, p. 104, fig. 72.)

Genre? sp. *nebulosa* Barrande, 1868, idem, pp. 693–694, unnumbered plate, fig. 69. (Copied from Barrande, 1868a, pp. 105–106, fig. 69.)

Discina contraria Barrande, Pompeckj, 1896, Tremadoc Fossilien bei Hof, p. 4. (Occurrence mentioned in German.)

The original description by Barrande follows:

This form, decidedly transverse, contrasts with the preceding, which is elongated. It also forms an ellipse, which, however, is truncated on the larger side. The shell presents only a slight bulge. The summit is placed somewhat beyond the center, going toward the truncated edge. Starting from the summit, the surface forms an inclined plane up to the contour. The perforation is linear and very short. The shell, partly preserved, presents very marked concentric striæ, at unequal intervals.

Longitudinal diameter, 6 mm.; transverse diameter, 9 mm.

Observations.—Pompeckj [1896a, p. 4] states that this species was found much more frequently than *O. varians* (Barrande), and that rather convex shells, 10 mm. long and 12 mm. broad, were not rare.

The generic relation of this species is doubtful. It is not *Discina*, nor from the evidence available can it be referred without question to *Orbiculoidea*.

Pompeckj, in reply to my inquiry as to whether he had identified "Genre? *nebulosa*" of Barrande, wrote as follows under date of August 7, 1906:

As to the *nebulosa* by Barrande (Faune silurienne des Environs de Hof, fig. 69) I find in notes made on the Barrande originals (in the collection of the Oberbergamt-Munich) that "*nebulosa*" is to be identified with Barrande's *Discina contraria*, l. c., figure 72. Both are pedicle valves of *Discina* with the characteristic perforation of that family below the apex. Both figures are incorrectly given. The two sharp lines radiating from the apex in figure 69 are only caused by pressure of the somewhat high shell, and in figure 72 the concentric striæ are indeed much more delicate than in the figures which represent an interior cast only, with bits of the shell in the upper part, i. e., near the hinge line.

Exact determination of these shells is very difficult; most of them (I saw more than a hundred) are compressed, crumpled, deformed, very seldom the apical region is clearly to be seen; shell rarely preserved; but there is indeed no doubt that they must belong to the Discinidæ on account of the "Schlitz" below the apex. There is no sharp difference between the rounded form, named *Discina varians* by Barrande, and between the larger and wider form, *D. contraria*, or *nebulosa*.

Formation and locality.—Passage beds between the Upper Cambrian and the Ordovician: (**303c** [*Barrande, 1868a, p. 104*]) *suburbs of Hof;* and (**303f** [Pompeckj, 1896a, pp. 7 and 8]) railway cut near Schellenberg, a little distance back of the railway station at Neuhof, near Hof; both in Bavaria, Germany.

Orbiculoidea pileolus (Hicks MS.) (Salter).

Plate LXXXI, figures 11, 11a.

Discina pileolus (Hicks MS.) Salter, 1866, Rept. British Assoc. Adv. Sci. for 1865, p. 285. (Mentioned.)

Discina pileolus Salter, Davidson, 1868, Geol. Mag., vol. 5, pp. 312–313, Pl. XVI, figs. 11–12. (Described and discussed; see p. 723 for copy of description. Figs. 11a and 12a are copied in this monograph, Pl. LXXXI, figs. 11 and 11a, respectively.)

Discina pileolus Salter, Davidson, 1871, British Fossil Brachiopoda, vol. 3, pt. 7, No. 4, p. 344, Pl. XLIX, figs. 41–42. (Original description, Davidson, 1868, pp. 312–313, copied. Figs. 41 and 42 are copied from Davidson, Pl. XVI, figs. 12 and 11, respectively.)

Not *Discina pileolus?* Hicks, 1871, Quart. Jour. Geol. Soc. London, vol. 27, pt. 1, Pl. XV, figs. 12 and 12a. (Referred in this monograph to *Stenotheca*.)

Orbiculoidea pileolus (Salter), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 137. (Changes generic reference.)

The original description by Davidson [1868, p. 312], follows:

Shell very small, circular or slightly longitudinal oval, rather broader anteriorly; about two and a half lines in length and a little less in breadth. Dorsal valve conical. Ventral valve slightly convex, depressed near the margin; vertex in both valves at a short distance from the center, as also the foramen (?) in the ventral valve. Surface marked with concentric lines, which are more strongly marked in the ventral valve. Interior not known.

I have not been able to secure specimens of this interesting shell, so can not add any personal observations upon it. Hall and Clarke [1892c, p. 137] suggest its reference to *Orbiculoidea* and in this, from our present information, I concur. As they have pointed out, it is the oldest representative of the genus.

Hicks [1871, Pl. XV, fig. 12] illustrates a depressed conical shell from the "Red" beds at the base of the "Purple" rocks, about 3,000 feet below the base of the Middle Cambrian "Menevian group" as "*Discina pileolus.*" Later [1881, p. 297] he calls the species "*Discina cærfaiensis.*" To me the shell is more suggestive of the gastropod genus *Stenotheca* than of a brachiopod and until I can obtain better material it will be so referred.

Formation and locality.—**Middle Cambrian**: (**318e**) Lower portion of the Menevian at Camlan, North Wales; (**318d**) *sandstones in the middle portion of the Menevian at Porth-y-rhaw, St. Davids, South Wales;* (**318p**) sandstones in the middle portion of the Menevian at Ninewells, near St. Davids, South Wales; (**318q**) yellowish-gray beds in the Harlech group, on the road between Solva and Whitechurch, St. Davids, South Wales; and (**318r**) sandstones in the middle portion of the Menevian at Solva Harbor, St. Davids, South Wales; all [Davidson, 1871, pp. 344 and 345] in Wales.

Orbiculoidea varians (Barrande).

Plate LXXXI, figure 8.

Discina varians Barrande, 1868, Faune silurienne des environs de Hof, en Bavière, pp. 103–104, fig. 71. (Described in French as a new species. Fig. 71 is copied in this monograph, Pl. LXXXI, fig. 8.)

Discina varians Barrande, 1868, Neues Jahrb. für Mineralogie for 1868, p. 692, unnumbered plate, fig. 71. (Copy of preceding reference.)

Discina varians Barrande, Pompeckj, 1896, Tremadoc Fossilien bei Hof, p. 4. (Occurrence mentioned in German.)

The original description by Barrande follows:

The form of this species is always elongated, but in proportions varying somewhat with the individuals. The surface is slightly arched. The summit is somewhat beyond the center of the figure, which is an ellipse, slightly truncated at the small end near the perforation. The perforation is linear and less than 1 mm. in length. The fragments of the shell that remain present traces of fine concentric striæ. The imperforate valve has not been observed. Length, 6 mm.; breadth, 5 mm.

Observations.—I am not able to add to the above description. It is evident that the species is not a *Discina*, as that genus is now understood, but with only a single figure and the above description it is not practicable to make a satisfactory generic reference. The subcentral apex with the elongate slit back of it, is more suggestive of *Orbiculoidea* than any other genus of the lower Paleozoic fauna.

Formation and locality.—**Passage beds** between the Upper Cambrian and the Ordovician: (**303c** [*Barrande, 1868a, p. 103*]) *suburbs of Hof;* and (**303f** [Pompeckj, 1896a, pp. 7 and 8]) railway cut near Schellenberg, a little distance back of the railway station at Neuhof, near Hof; both in Bavaria, Germany.

Superfamily CRANIACEA Waagen.

Family CRANIIDÆ King.

Genus PHILHEDRA Koken.[a]

Philhedra Koken, 1889, Neues Jahrb. für Mineralogie, Beilage-Band 6, Hft. 3, p. 465. (Discussed in German as a new genus.)

Philhedra Koken, von Huene, 1899, Neues Jahrb. für Mineralogie, Bd. 1, pp. 146–147. (Described and discussed in German. See below for translation of diagnosis.)

Philhedra Koken, von Huene, 1899, Verhandl. Russ.-kais. min. Gesell. St. Petersburg, 2d ser., Bd. 36, Lief. 2, pp. 216–218 (list of species referred to *Philhedra*), and pp. 297–298. (Described and discussed in German.)

Philhedra Koken, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 147. (Classification of genus.)

The emended diagnosis of the species by von Huene follows:

Inequivalve, with the flat ventral shell attached. Dorsal shell subconical to bowl-shaped, frequently irregularly bent; the concentric growth lines are mostly crossed by radial ribs or rows of prickles; without limbus. Anterior occlusors larger than posterior occlusors.

Type.—Patella rivulosa Kutorga.

Von Huene, in his memoir on the Silurian Craniidæ [1899b, pp. 181–359], redefines the genus *Philhedra* of Koken, and considers *P. columbiana* (Walcott) as its oldest representative. The student who wishes to pursue the study further should read von Huene's memoir on the Silurian Craniidæ [1899b, pp. 181–359] and his "Systematik der Craniaden" [1899a, pp. 138–151].

Philhedra columbiana (Walcott).

Plate LXXXI, figure 10.

Crania? columbiana Walcott, 1889, Proc. U. S. Nat. Mus. for 1888, vol. 11, p. 441. (Described and discussed as a new species.)

Crania? columbiana Walcott, von Huene, 1899, Neues Jahrb. für Mineralogie, Bd. 1, p. 141, footnote. (Mentioned.)

Philhedra? columbiana (Walcott), von Huene, 1899, Verhandl. Russ.-kais. min. Gesell. St. Petersburg, 2d ser., Bd. 36, Lief. 2, pp. 216 and 298. (Mentioned.)

Crania columbiana Walcott, Matthew, 1902, Trans. Roy. Soc. Canada for 1902, 2d ser., vol. 8, sec. 4, No. 3, pp. 108–109. (Copies the original description, Walcott, 1889c, p. 441.)

Philhedra columbiana Walcott, 1908, Canadian Alpine Journ., vol. 1, No. 2, Pl. I, figs. 5 and 5a. (No text reference. Figs. 5 and 5a are copied in this monograph, Pl. LXXXI, figs. 10 and 10′, respectively.)

Shell small, subcircular, or a little longer than wide, subconical with the apex slightly eccentric. Outer surface exfoliated; the inner layer of the shell appears to have been composed of a calcareocorneous substance; it is marked by from 40 to 45 fine ribs that radiate from the apex to the margin. Diameter about 2 mm. When preparing this monograph I carefully examined the original specimen, removed a little of the attached matrix from the outer margins and discovered traces of what appear to be minute spines radiating from the margin.

Many collections from the type locality of this species have passed through my hands from 1888 to 1906, but it was not until the summer of 1907 that another specimen was seen, and then only two were found in the *Ogygopsis* zone of Mount Stephen. These are both crushed and broken specimens of the inner side of the conical valve. There is a striking similarity in appearance between this shell and *Crania lælia* Hall and Clarke [1892c, Pl. IV H, fig. 1] and other similar forms.

The specific name is derived from British Columbia.

Formation and locality.—**Middle Cambrian**: (14s) About 2,300 feet (701 m.) above the Lower Cambrian and 2,700 feet (823 m.) below the Upper Cambrian, in the *Ogygopsis* zone of the Stephen formation [Walcott, 1908f, p. 210], on the northwest slope of Mount Stephen, above Field on the Canadian Pacific Railway, British Columbia, Canada.

[a] The synonymy for this genus is not complete and does not even give a record of all the genera under which the Cambrian species of *Philhedra* has been placed; it gives only those references in which the genus is discussed or described. To complete the record for the species taken up in this monograph the following mere references are listed:

Crania? Walcott [1889c, p. 441].
Crania? von Huene [1899a, p. 141].
Crania Matthew [1902c, p. 108].

Order PROTREMATA Beecher.

[πρό, early; and τρῆμα, perforation.]

Superfamily ORTHACEA Walcott and Schuchert.

Family BILLINGSELLIDÆ Schuchert.

Subfamily NISUSIINÆ Walcott and Schuchert.

Genus NISUSIA Walcott.[a]

Billingsella Hall and Clarke (in part), 1892, Nat. Hist. New York, Paleontology, vol. 8, pp. 230–231. (Described and discussed as a new genus. As described the genus includes species that are now referred to *Nisusia*.)
Nisusia Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 247–248. (Described essentially as below as a new genus.)
Nisusia Walcott, Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 210. (Characterized.)
Nisusia Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 147. (Classification of genus.)

Form subquadrate to transversely semioval. Shell structure dense with a minutely granular groundmass with minute pores penetrating some of the lamellæ forming the shell. The pores vary greatly in number and arrangement. Surface with narrow, radiating ribs that support irregularly distributed spines on their crests.

Ventral valve elevated and usually much more convex than the dorsal, and in most species a mesial sinus appears on it. Area high, vertical or inclined backward; delthyrium large and partly closed with a convex deltidium; teeth strong and supported by dental plates that extend outward, also inward, forming on the inside a shallow spondylium. Dorsal valve moderately convex with only a trace of a median elevation; usually the surface is convex, but it may be slightly concave from the umbo to the margins; crura well developed, with the crural plates extended so as to form a shallow cruralium. No traces of a cardinal process have been observed in the dorsal valve.

Type.—Orthisina festinata Billings.

Observations.—A comparison of the area of the ventral valve of *Nisusia* with that of the same valve in *Billingsella* shows in each a convex deltidium partly covering a large triangular delthyrium. In *Billingsella* the upper extremity of the deltidium is perforate and it is probably so in *Nisusia*, but on this point there is an uncertainty, as no specimen has been found clearly showing the pedicle opening. It may be that the deltidium of *Nisusia* was perforate in the younger stages of growth and subsequently filled by shell growth. The strong vascular sinuses of the ventral valve of *Billingsella* are absent in *Nisusia*, as well as the tripartite division of the umbonal cavity. The interiors of the dorsal valves of the two genera show marked differences. The cardinal process is well developed in *Billingsella* but not in *Nisusia*. There is a small, shallow cruralium in *Nisusia* but none in *Billingsella*. The dorsal valve of *Nisusia* has a clearly developed cruralium, but not any trace of a cardinal process. The ventral valve of *Billingsella* shows a tendency to form a spondylium resting on the interior of the valve, a character unknown in *Nisusia*.

The general form of *Nisusia* is not unlike that of *Billingsella* except that its ventral valve has a more erect beak and cardinal area. These comparisons include such species of *Billingsella* as *B. coloradoensis*, *B. plicatella*, and *B. exporrecta*, but not *B. dice* (Pl. CI, figs. 8, 8a–c). Of *Nisusia*, they include *N. festinata* and some of the subgenus *Jamesella*, such as *N.* (*J.*) *perpasta*, *erecta*, and *amii*.

Billingsella and *Nisusia* both occur in Lower Cambrian strata, but *Billingsella* has its greatest development in the Middle Cambrian and *Nisusia* in the Lower Cambrian. It is not

[a] The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Nisusia* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Orthisina de Verneuil and Barrande [1860, p. 533].
Orthisina Billings [1861b, p. 10; 1861c, p. 949; 1862b, p. 105; 1862e, p. 221; 1863, p. 284].
Orthisina Mallada [1875, p. 32].
Orthisina Walcott [1886b, pp. 120 and 121; 1889c, p. 442; 1891a, p. 613].
Orthisina Tate [1892, p. 185].
Billingsella Schuchert [1897, p. 158].
Orthisina Matthew [1902c, p. 109].

probable that either genus is directly descendant from the other, but I think that both came from an ancestor that lived in early Lower Cambrian time and that *Billingsella* is further advanced in its development than *Nisusia*.

Nisusia alberta (Walcott).

Plate C, figures 3, 3a–d.

Orthisina alberta Walcott, 1889, Proc. U. S. Nat. Mus., vol. 11, p. 442. (Described as a new species.)
Billingsella alberta (Walcott), Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 158. (Merely changes generic reference.)
Orthisina alberta Walcott, Matthew, 1902, Trans. Roy. Soc. Canada, 2d ser., vol. 8, sec. 4, No. 3, p. 109. (Original description, Walcott, 1889c, p. 442, copied.)
Nisusia alberta Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 248–249. (Described and discussed essentially as below.)
Nisusia alberta Walcott, 1908, Canadian Alpine Jour., vol. 1, No. 2, p. 245, Pl. I, figs. 4 and 4a. (No text reference. Figs. 4 and 4a are copied in this monograph, Pl. C, figs. 3c and 3d, respectively.)

Shell transversely suboval, front broadly rounded; the straight hinge line is shorter than the full width of the valves. Surface of shell with numerous radiating ribs that increase by interpolation; on a shell 19 mm. in width there are four ribs near the front margin in a distance of 3 mm.; the ribs are rather narrow and sharp crested, the interspaces being wider than the ribs. A cast of the outer surface of a shell in siliceous shales shows numerous strong spines irregularly distributed on the ribs very much as in *N. festinata* (Pl. C, fig. 3c).

Ventral valve elevated at the umbo and apex in some shells, convex and rounded over toward the area in others; area varying in height in different shells, usually elevated and overhanging the hinge line; it is divided by a strong delthyrium that is covered by a convex deltidium of varying length, arched at its front margin and divided by longitudinal lines into three parts.

Dorsal valve gently convex; area low, and a little inclined over the hinge line; delthyrium broad with a narrow chilidium. Casts of the interior show a broad, well-defined pseudocruralium and just in advance of it the adductor muscle scars.

Observations.—This species recalls at once *Nisusia festinata* by its elevated ventral valve and spinose surface; it differs from it by its transversely suboval outline, large umbonal muscle cavity (pseudocruralium) in the dorsal valve and sharp crested ribs. *Nisusia* (*Jamesella*) *perpasta* has the general form and surface characters of this species. A marked difference is caused by *N. alberta* occurring in a siliceous shaly matrix and *N.* (*Jamesella*) *perpasta* as casts in a quartzitic sandstone, and the strong surface spines of *N. alberta* are sparingly represented on the latter. A shell that appears to be identical with this species occurs at about 1,600 feet above the base of the Middle Cambrian terrane in Utah.

The specific name is derived from Alberta, Canada.

Formation and locality.—**Middle Cambrian**: (**14s**) *About 2,300 feet (701 m.) above the Lower Cambrian and 2,700 feet (823 m.) below the Upper Cambrian in the Ogygopsis zone of the Stephen formation [Walcott, 1908f, p. 210], at the "fossil bed," on the northwest slope of Mount Stephen;* and (**35k**) Burgess shale member of the Stephen formation on the west slope of the ridge between Mount Field and Wapta Peak, 1 mile (1.6 km.) northeast of Burgess Pass; both above Field on the Canadian Pacific Railway, British Columbia, Canada.

Specimens that probably belong with *Nisusia alberta* occur at the following locality, together with other specimens that are somewhat doubtfully referred to the species:

Middle Cambrian: (**54q**) A drift block supposed to have come from a horizon 1,700 feet (518.2 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], found near the mouth of Wasatch Canyon, east of Lakeview ranch, 5 miles (8 km.) north of Brigham, Boxelder County, Utah.

Specimens that appear to represent a variety of *Nisusia alberta* occur at the following localities:

Middle Cambrian: (**57c** and **57k**) About 2,500 feet (762 m.) above the Lower Cambrian and 2,475 feet (754 m.) below the Upper Cambrian in the limestone forming 1 of the Stephen formation [Walcott, 1908f, p. 209]; and (**58z**) about 1,875 feet (572 m.) above the Lower Cambrian and 3,100 feet (945 m.) below the Upper Cambrian in the lime-

stone forming 2b of the Stephen formation [Walcott, 1908f, p. 211]; both on Mount Bosworth, north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide between British Columbia and Alberta, Canada.

(57j) About 2,000 feet (609.6 m.) above the Lower Cambrian in the limestone forming 2 of the Stephen formation [Walcott, 1908c, p. 237 (6)], just east of the "fossil bed," on the northwest slope of Mount Stephen, above Field on the Canadian Pacific Railway, British Columbia, Canada.

Lower Cambrian: (58k) Just below the Middle Cambrian in the limestone forming 1 of the Mount Whyte formation [Walcott, 1908c, p. 240 (9)], just above the tunnel; and (58p) drift block of limestone believed to have come from the limestone forming 1 of the Mount Whyte formation [Walcott, 1908c, p. 240 (9)], found near the Canadian Pacific Railway track just west of the tunnel; both 3 miles (4.8 km.) east of Field, British Columbia, Canada.

Nisusia compta (Tate).

Plate XCVII, figure 14.

Orthisina compta Tate, 1892, Trans. Roy. Soc. South Australia, vol. 15, p. 185, Pl. II, figs. 6 and 6a. (Described as a new species. The specimen represented by figs. 6 and 6a is redrawn in this monograph, Pl. XCVII, fig. 14.)

Form transversely subquadrilateral with the hinge line a little shorter than the greatest width of the shell. Surface of the shell marked by strong, concentric ridges of growth that cause undulations of variable extent, also fine radiating, rounded, depressed ribs that are a little wider than the interstitial furrows. The outer surface is exfoliated, but the interior lamellæ of the shell show small, irregularly distributed nodes on the ribs that are considered to be the bases of spines similar to those on the surface of *Nisusia festinata* (Billings) (Pl. C, fig. 1) and *N. alberta* (Walcott) (Pl. C, fig. 3c).

The ventral valve is moderately convex with a low median fold. Area of medium width and projecting slightly backward; it is divided midway by a rather broad, triangular delthyrium that is nearly covered by a convex deltidium; the area and delthyrium are marked by fine transverse lines of growth.

Length of valve from beak to incurve of median fold, 6 mm.; greatest width, 9 mm.; length of hinge line, 7 mm.

Observations.—This species is represented in the collection before me by a single specimen. This appears to be a ventral valve, but, unlike the ventral valve of *N. festinata* (Pl. C, figs. 1, 1a–d), which has a median sinus, it has a median fold. The area and convex deltidium are like those of the ventral valve of *N. festinata*. The fine ribs and quadrate form distinguish this species from other species of the genus.

Formation and locality.—**Middle? Cambrian:** (315 [Tate, 1892, p. 185]) Limestone at Curramulka, Yorke Peninsula, South Australia.

Nisusia festinata (Billings).

Text figure 6, page 299; Plate C, figures 1, 1a–j, 2, 2a–c.

Orthisina festinata Billings, 1861, Geol. Survey Canada, Paleozoic Fossils, vol. 1, p. 10, figs. 11 and 12. (Described as a new species.)

Orthisina festinata Billings, 1861, Report on the Geology of Vermont, vol. 2, p. 949, figs. 350–352. (Text and figures copied from preceding reference.)

Orthisina festinata Billings, 1862, Am. Jour. Sci., 2d ser., vol. 33, p. 105. (Discussed.)

Orthisina festinata Billings, 1862, Report on the Economic Geology of Vermont, by Hager, p. 221, figs. 350–352. (Text and figures copied from Billings, 1861b, p. 10, figs. 11 and 12.)

Orthisina festinata Billings, 1863, Geol. Survey Canada, Fifteenth Rept. Progress, figs. 289a–c, p. 284. (No text reference. The figures are copied from Billings, 1861b, figs. 11 and 12, p. 10.)

Orthisina festinata Billings, Walcott, 1886, Bull. U. S. Geol. Survey No. 30, pp. 120–121, Pl. VII, figs. 7, 7a-b. (Original description, Billings, 1861b, p. 10, copied. The two specimens represented by figs. 7 and 7a–b are redrawn in this monograph, Pl. C, figs. 1a and 1h, respectively.)

Orthisina festinata Billings, Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 613, Pl. LXXII, figs. 7, 7a–b. (Mentioned. The figures are copied from the preceding reference.)

Billingsella festinata (Billings), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 230. (Merely changes generic reference.)

Nisusia festinata (Billings), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 249–251. (Described and discussed essentially as on p. 728.)

Nisusia festinata (Billings), Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 211, fig. 249, p. 210. (Described. Fig. 249 is copied from Walcott, 1886b, Pl. VII, figs. 7, 7a–b.)

General form subquadrate to transversely semioval, with the cardinal extremities subacute to obtusely angular. Hinge line straight, usually equal to or greater in length than the width of the body of the shell. Shell substance dense, granular, with minute pores arranged in scattered radiating lines; none of the pores appear to pass through more than one lamella of the shell.

Surface with narrow, rounded, radiating ribs, that increase by both bifurcation and interpolation; the ribs are roughened by concentric lines and ridges of growth that arch about the base of strong, acute spines; the spines are located on the ribs, usually just back of a ridge of growth; they are in more or less irregular, concentric rows toward the front of the shell, but on the central portions they may be scattered without any system of arrangement; each spine is larger at the base, tapering rapidly, and curving gradually backward at about one-half its length.

The ventral valve is more or less elevated at the umbo and apex; in some examples it is subpyramidal (Pl. C, fig. 1e), where the height is to the length as 3 to 6, and width 9 mm.; in other shells the proportion is 4 to 11, and width 17 mm.; the slopes from the apex to the margins are nearly straight or slightly convex; the form of the umbo and apex varies from a broad, rounded umbo terminating in a minute beak curving over the area, to an erect, vertical, more or less rounded apex, with a broad base rising abruptly from the elevated umbo; a shallow, rounded, median sinus occurs on most shells, but it is sometimes absent. Area high, and crossed by transverse lines of growth; it is usually inclined over the hinge line, but it may be vertical or inclined forward (fig. 1e); it is divided by a strong delthyrium, which is covered by a convex deltidium that the author of the species, Billings, describes [1861c, p. 10] as perforate at the apex.[a] I have not been able to verify this in a large collection of material from various localities; casts of the interior of the extended beak indicate but do not prove that there was a perforation; the front edge of the deltidium is arched so as to leave a space of variable height between it and the plane of the hinge line; in three examples the area is divided into three parts by longitudinal lines (Pl. C, fig. 1e″), two of the lines bound the delthyrium, and one on each side corresponds in position to the "flexure" lines in *Obolus* and *Hipparionyx*. A cast of the interior of a low ventral valve (Pl. C, fig. 1f′) shows a broad delthyrium, strong teeth, and supporting dental plates which are produced on the inside so as to form a short, elevated base (pseudospondylium), and on the outside the plates are continued partly about the space occupied by the points of attachment of the diductor muscles.

The dorsal valve is moderately convex at the umbo, sloping gently from there to the margins; usually the slope is convex, but in one example it is slightly concave; area narrow and vertical or slightly inclined over the hinge line; casts of the interior show the crura, points of attachment of posterior adductor scars (e, Pl. C, fig. 1g; see fig. 3a), area of attachment of diductor scars (d′, Pl. C, figs. 1g, 1i). Vascular and ovarian markings unknown.

Observations.—This shell has a wide geographic distribution. I have collected it at the type locality in the township of Georgia, Vermont; at Bic on the lower St. Lawrence River; and near York, Pennsylvania. The matrix at Bic is a finely granular, slightly arenaceous limestone in which the outer form of the shell is well preserved, but the spines are rarely seen. At Swanton and Georgia, Vermont, the shell occurs in siliceous limestone and arenaceous shale, and a cast of the outer surface shows the spines; the material from the finely arenaceous limestone at the Emigsville localities, discovered by A. Wanner, of York, Pennsylvania, is the best preserved and affords excellent casts of the interior and exterior of the valves. In all of the localities the variation in the form and elevation of the ventral valve occurs; specimens of the ventral valve from Bic, Canada, show a shorter deltidium than is usually present. A number of exfoliated shells occur in the collection from the dark-gray compact limestones of eastern New York and are doubtfully referred to this species.

[a] Through the courtesy of Dr. J. F. Whiteaves, of the Geological Survey of Canada, I had the opportunity of examining the types of "*Orthisina festinata*." None of them preserve the apex of the deltidium, so it is impossible to determine upon what Billings based his statement that the deltidium was perforate.

Nisusia festinata is a strongly marked species that appears to have but one near representative in form, *N.* (*Jamesella*) *perpasta.* It differs from the latter species in the absence of spines and in the form of the ventral valve.

FORMATION AND LOCALITY.—**Lower Cambrian:** (392a) Limestones at L'Anse au Loup, on the north shore of the Straits of Belleisle, Labrador.

(2o) Limestone bowlders in conglomerate, on shore at east entrance to harbor at Bic, Rimouski County, Quebec, Canada.

(25a) Limestone on the Hall (Donaldson's) farm, 2 miles (3.2 km.) east of Swanton; (319e [*Billings, 1861b, p. 10*]) *limestone 2 miles (3.2 km.) east of Swanton;* (25) sandstone just above Parker's quarry, near Georgia; (319m) shales of No. 6 of the section at Parker's quarry [Walcott, 1891b, p. 278], near Georgia; (26) sandstone northeast of the Corman farm buildings, east of Highgate Springs; and (392p) shale on the Jewell farm; all in Franklin County, Vermont.

(319w) Limestone 1.25 miles (2 km.) north of Rutland, Rutland County, Vermont.

(38a) Limestone 2 miles (3.2 km.) south of North Granville, on the road which turns south from the road running between that village and Truthville, 4 miles (6.4 km.) west-northwest of Granville, Fort Ann quadrangle (U. S. Geol. Survey); and (36) limestone 1 mile (1.6 km.) south of Shushan and 3.5 miles (5.6 km.) north-northeast of Cambridge, Cambridge quadrangle (U. S. Geol. Survey); both in Washington County, New York.

(49) Sandstone on Codorus Creek, 0.125 mile (0.2 km.) below Meyer's mill, near Emigsville; (49a) sandstone on the Liverpool road, south of the schoolhouse, 3 miles (4.8 km.) northwest of York; (346e) shale near York; and (49w) limestone in railroad cut 0.25 mile (0.4 km.) south of Emigsville; all in York County, Pennsylvania.

(35f) About 300 feet (91 m.) below the Middle Cambrian in the limestone forming 6 of the Mount Whyte formation [Walcott, 1908c, p. 242 (11)] just above the tunnel on the north shoulder of Mount Stephen, about 3 miles (4.8 km.) east of Field, British Columbia, Canada.

(35h) About 375 feet (114 m.) below the Middle Cambrian in the shales of No. 4 of the Mount Whyte formation [Walcott, 1908f, p. 214], on Mount Bosworth, north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide between British Columbia and Alberta, Canada.

NISUSIA FESTINATA TRANSVERSA (Walcott).

Plate C, figures 4, 4a–b.

Orthisina? transversa WALCOTT, 1886, Bull. U. S. Geol. Survey No. 30, p. 121, Pl. VII, figs. 5 and 5a. (Described as below as a new species. The specimens represented by figs. 5 and 5a are redrawn in this monograph, Pl. C, figs. 4 and 4a, respectively.)

Orthisina? transversa WALCOTT, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 613, Pl. LXXII, figs. 9 and 9a. (No text reference. Figs. 9 and 9a are copied from figs. 5 and 5a, respectively, of the preceding reference.)

Nisusia festinata transversa WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 251. (Original description copied as below and species placed as variety of *Nisusid festinata.*)

Shell small, transversely subquadrangular in outline, front broadly rounded, angle formed by the union of the cardinal slopes of the ventral valve 155° to 165°, hinge line straight and as long as the width of the shell. Area of the ventral valve of moderate height, bent back from the hinge line, divided by a triangular foramen that is higher than wide and covered by a convex deltidium; the area of the dorsal valve is bent back at more than right angles to the hinge line; foramen higher than wide, covered by a deltidium.

Surface marked by numerous radiating, fine, even costæ, eight in a distance of 3 mm. on the frontal margin of the ventral valve; a few concentric lines of growth cross the radiating costæ, but not so as to give them a nodose character.

Interior characters unknown. The fine radiating striæ and transverse form distinguish this from other described species known to me.

FORMATION AND LOCALITY.—**Lower Cambrian:** (25) *Sandstone just above Parker's quarry, near Georgia;* (319m) shales of No. 6 of the section at Parker's quarry [Walcott, 1891b, p. 278], near Georgia; and (25a) limestone on the Hall (Donaldson's) farm, 2 miles (3.2 km.) east of Swanton; both in Franklin County, Vermont.

NISUSIA RARA Walcott.

Text figure 60, page 730.

Nisusia rara WALCOTT (in part), 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 97, Pl. IX, fig. 13a (not fig. 13, which represents a specimen of *Eoorthis thyone*). (Characterized and discussed as below as a new species. Fig. 13a is copied in this monograph as fig. 60, p. 730.)

The ventral valve of this species has the same general form as that of *Nisusia festinata* (Billings) (Pl. C, figs. 1d and 1e) except that it has a very strong and deep median sinus and

is more transverse; the delthyrium is also larger. *Nisusia rara* occurs at the same stratigraphic horizon as *Nisusia alberta* (Walcott), but it differs from the latter in having a larger delthyrium and a strong and deep median sinus.

The surface of *N. rara* is marked by rounded radiating ribs that increase by interpolation and bifurcation; small nodes on some of the ribs indicate the presence of spines on the outer surface. A portion of a convex deltidium is shown that has the outer portion broken away. The type specimen has a length of 8 mm.; width, 16 mm.

FORMATION AND LOCALITY.—**Middle Cambrian: (55c)** Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], about 50 feet (15.2 m.) above the Brigham quartzite and 2,755 feet (839.7 m.) below the Upper Cambrian, in a ravine running up into Danish Flat from Mill Canyon, about 6 miles (9.6 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho.

FIGURE 60.—*Nisusia rara* Walcott. Cast of the interior of a dorsal valve (U. S. Nat. Mus. Cat. No. 52295a, labeled 52295b [Walcott, 1908d, p. 123] by error).[a]

The specimen represented is from Locality 55c, Middle Cambrian Spence shale, near Liberty, Idaho. The figure is copied from Walcott [1908d, Pl. IX, fig. 13a].

NISUSIA? VATICINA (de Verneuil and Barrande).

Plate XCVII, figures 3, 3a–b.

Orthisina vaticina DE VERNEUIL and BARRANDE [not SALTER MS.], 1860, Bull. Soc. géol. France, 2d ser., vol. 17, pp. 533–535, Pl. VIII, figs. 8, 8a–d. (Described and discussed in French as a new species; see below for translation. Figs. 8, 8b–c are copied in this monograph, Pl. XCVII, figs. 3, 3a–b, respectively.)

Orthisina vaticina de Verneuil and Barrande, MALLADA, 1875, Bol. Com. Mapa Geológico España, tome 2, p. 32. (Mentioned.)

The original description by de Verneuil and Barrande follows:

Shell subquadrangular, slightly emarginate below the lateral extremities. Length equal to three-fourths of the breadth. Hinge ridge somewhat shorter than the greatest width of the shell. Ventral valve twice as thick as the dorsal, area double in height. Triangular opening on each of the valves, covered in part by a deltidium. At the point of the beak there is a very fine opening, hardly visible, which is obliterated in certain specimens. The valves are regularly bulged and have no marked sinus, so that their edge is straight. The surface is ornamented with fine, dichotomous, spiny striæ; these spines, or tubes, which are 1 or 2 mm. long on the ventral valve, are hardly seen on the other valve. At 10 mm. from the beak, where the striæ subdivide by dichotomy, six of them are counted in a space of 5 mm.

Dimensions: Length, 18 mm.; breadth, 24 mm.; thickness, 8 mm.

Relations and differences: This species belongs to the *Orthis* group, united by one of us under the name of *Recto striatæ*[b] and which Davidson includes in the genus *Orthisina* of d'Orbigny.[c] The two characteristics of this group consist in the direction of the striæ, which, starting from the beak, never curve backward to reach the hinge crest, and in the presence of a deltidium which covers the triangular cleft of the area. The hole with which this deltidium is sometimes pierced, a characteristic on which d'Orbigny established the genus *Orthisina*, is of altogether secondary importance, for it appears to be only temporary. We have demonstrated that in certain Leptænæ, which have an opening analogous to that of the species under discussion, that characteristic produces no significant change in the internal apparatus.[d]

In having its striæ provided with tubes or spines this species is distinguished from all others, except *O. striatula*, with which it is impossible, on other accounts, to confound it. It may be compared either to *O. romingeri* Barrande, from the primordial zone of Bohemia, which is distinguished by a rather pronounced sinus on the small valve, a more prominent beak and smooth striæ; or with *O. inflexa* Pander, from the lower Silurian strata of St. Petersburg, which is thicker, as observed especially in the dorsal valve, which in this respect is almost equal to the opposite valve. Moreover the striæ of the Russian species are never spinous.

Mr. Salter, whose kindness is never appealed to in vain, thought he recognized in our specimens a species found recently in the *Lingula* beds, to which, in the collection of the museum of practical geology at London, he gave the name *O. vaticina*, under which we publish it.

Observations.—In appearance this shell is closely related to Lower Ordovician species of *Clitambonites* that have a fimbriated surface. If, as the authors state, many of the shells are imperforate, then it is probable that the species is closely related to and belongs with *Nisusia*, although the illustration of the spines indicates that they were of a different character from those of *Nisusia festinata* (Billings). In the presence of the statement that the shells are associated with the Primordial fossils (*Paradoxides*, etc.) and the absence of an opportunity to

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[a] See the note accompanying the first reference in the synonymy of *Eoorthis thyone*, p. 789, and the note following text figures 70A–C, p. 789.

[b] Murchison, de Verneuil, et de Keyserling, Géologie de la Russie d'Europe et de l'Oural, vol. 2, 1845, p. 179. Bull. Soc. géol. France, 2d ser., vol. 2, 1845, p. 481.

[c] Davidson, Introduction à l'histoire naturelle des brachiopodes, French translation by Deslongchamps, p. 130.

[d] De Verneuil, Bull. Soc. géol. France, 2d ser., vol. 5, 1848, p. 348.

study the actual specimens, I think it best to refer the species to *Nisusia*. "*Orthis vaticina*" was a manuscript name given by Salter to shells subsequently referred to "*Orthis lenticularis*" by Davidson [1869, p. 231].

FORMATION AND LOCALITY.—**Middle Cambrian**: (350 [de Verneuil and Barrande, 1860, p. 538]) Red limestone of the *Paradoxides* zone, near Adrados, north of Sabero and Boñar, Cantabrian Mountains, Province of Leon, northwestern Spain.

JAMESELLA Walcott,[a] subgenus of NISUSIA.

Nisusia (*Jamesella*) WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 252. (Characterized as below as a new subgenus.)
Nisusia (*Jamesella*) WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 147. (Classification of genus.)

There are several species of Lower Cambrian brachiopods that differ from *Nisusia festinata* in the absence of the strong spines on the radiating ribs. This character is so marked that I separate the species without it as a subgeneric group.

Type.—Orthis perpasta Pompeckj.

The subgeneric name is in memory of Dr. Joseph F. James, a paleontologist who assisted me in the preparation of material for the study of the *Olenellus* fauna.

NISUSIA (JAMESELLA) AMII Walcott.

Plate CI, figures 6, 6a–b.

Nisusia (*Jamesella*) *amii* WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 252. (Described and discussed as below as a new species.)

Ventral valve convex, elevated at the umbo, with the beak slightly incurved; area high, vertical, slightly incurved; delthyrium triangular, higher than its greatest width and covered by a convex deltidium, which is imperforate. Surface of shell marked by numerous fine, rounded, equidistinct ribs that increase by interpolation; about 8 ribs in a distance of 2 mm. at frontal margin. Size: Length, 8 mm.; width, 10 mm.; elevation at umbo, 4 mm.

The front margin of the deltidium is broken so that it is impossible to state whether it was arched as is the deltidium of *Nisusia festinata* (Billings). There is no trace of a foraminal aperture in the deltidium. The fine, regular ribs and high area serve to distinguish this from other species of the genus. Dorsal valve unknown.

The specific name was given in honor of Dr. H. M. Ami.

FORMATION AND LOCALITY.—**Lower Cambrian**: (56a) A limestone bowlder in the Sillery conglomerate, on the south shore of St. Lawrence River 4 miles (6.4 km.) below Quebec, Canada.

NISUSIA (JAMESELLA) ARGENTA Walcott.

Plate CI, figures 9, 9a–b.

Nisusia (*Jamesella*) *argenta* WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 252. (Described and discussed somewhat as below as a new species.)

The outline of the ventral valve is subrectangular, with the hinge line a little shorter than the greatest width. Strongly convex with a keel-like median elevation extending from the incurved beak over the elevated umbo to the front margin, with gradually increasing width. Area low, with the minute beak curving down to and possibly slightly over it.

Dorsal valve depressed, convex, with a rather strong median fold (Pl. CI, fig. 9b); area unknown.

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[a] The synonymy for this subgenus does not give a complete record of the various genera under which the species now included in *Jamesella* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Orthis Feistmantel.
Orthis Jahn.
Orthis Katzer.
Orthis Krejci.
Orthis Kusta.
Orthis Novak.
Orthis Wentzel.
Orthisina de Verneuil and Barrande [1860, p. 535].
Orthis Pompeckj [1896b, p. 514, 515, and 516].
Protorthis Walcott [1905a, pp. 283 and 285].

Surface marked by fine, concentric striæ of growth and about five sharp, elevated, radiating ribs on each side of the two ribs on the median ridge of the ventral valve; the ribs of the dorsal valve are more regular in spacing and size.

Observations.—This shell has such strong characters that I unhesitatingly give it a specific name. The only form known to me that resembles it is *N.* (*J.*) *kuthani* (Pompeckj) (Pl. CI, figs. 4, 4a–b) from Bohemia.

FORMATION AND LOCALITY.—**Lower Cambrian**: (1m and 1p)[a] Limestones of No. 2 of the Silver Peak group, Barrel Spring section [Walcott, 1908f, p. 189], about 2.5 miles (4 km.) south of Barrel Spring and 0.5 mile (0.8 km.) east of the road, in the extreme southeast corner of the Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County, Nevada.

NISUSIA (JAMESELLA) ERECTA Walcott.

Plate CI, figures 5, 5a–b.

Nisusia (*Jamesella*) *erecta* WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 253. (Described essentially as below as a new species.)

General form transversely semioval; hinge line a little shorter than the greatest width; Valves subequally convex. Surface marked by strong, broad, sharply rounded ribs, three at the frontal margin in a distance of 2 mm.; the ribs appear to be simple and unbifurcated from the umbo to the margin, but owing to the small size of the shell this statement may be modified by discovery of other specimens. Width, 9 mm.; length, 7 mm. from beak to front of ventral valve.

Ventral valve convex; elevated at the umbo, beak marginal. Area high, very slightly inclined backward; delthyrium large, triangular, length and width equal; deltidium convex, imperforate, and nearly covering the delthyrium. Dorsal valve regularly convex, most elevated at the umbo and curving over to the rather low area.

This species is distinguished by its strong, regular ribs and regular convexity of the dorsal valve.

FORMATION AND LOCALITY.—**Middle Cambrian**: (313g) Limestone at the south end of the Timpahute Range, Groome district, near the line between Nye and Lincoln counties, Nevada.

NISUSIA ? (JAMESELLA ?) KANABENSIS Walcott.

Nisusia ? (*Jamesella ?*) *kanabensis* WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 97–98. (Described and discussed as below as a new species.)

This species is represented by a single broken interior cast of a small ventral valve that has a length of 3.5 mm.; width, about 5 mm. The cast is convex, with the base of a prominent extension that filled the interior of the beak. The surface is finely papillose, which proves that the interior surface was finely punctate. The casts of the ribs show them to have been rather sharply rounded and to have increased by bifurcation and interpolation; the absence of all traces of casts of spine bases on the ribs leads me to refer the species to the subgenus *Jamesella*. Area shown only by a narrow rim on one side. The delthyrium was probably quite broad.

The reference of this shell to *Nisusia* is based on the evidence of the presence of a prolonged beak and the character of the ribs. The genus is doubtful, but I do not know of any other to which a tentative reference could be made.

The specific name is derived from Kanab Canyon, the type locality.

FORMATION AND LOCALITY.—**Upper Cambrian**: (75) Thin-bedded limestones just below the base of the Ordovician, in the Tonto group, near the water's edge at the mouth of Kanab Canyon, Grand Canyon of the Colorado, Arizona.

NISUSIA (JAMESELLA) KUTHANI (Pompeckj).

Plate CI, figures 4, 4a–b.

Orthis kuthani POMPECKJ, 1896, Jahrb. K.-k. geol. Reichsanstalt, Bd. 45, pp. 514–515, Pl. XV, figs. 8–13. (Described and discussed in German as a new species; see p. 733 for translation.)

Orthis romingeri of the following authors: KREJCI, NOVAK, K. FEISTMANTEL, KUSTA, KATZER, WENTZEL, and JAHN.

[a] **1p** is the type locality.

Nisusia (Jamesella) kuthani Pompeckj, Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 253–254. (Original description, Pompeckj, 1896b, p. 514, copied, and species discussed as below.)

The original description by Pompeckj follows:

Outline subrectangular, hinge edge straight with angles protracted but a short distance; length to breadth as 3 : 4, often less.

Ventral valve highly arched. Apex drawn forward, but not curved toward the dorsal valve at all, or in rare cases but slightly. Area high, steep, with sharp areal edges and high, triangular foramen. Owing to the state of preservation, the details of the interior of the valves can not be well observed.

Dorsal valve flatter, with rather decided arching on side edge and frontal edge, with sinus always distinct, which corresponds to a faint swelling at the frontal edge of the ventral valve. The area is very low with a small triangular foramen. Crural processes narrow, considerably divergent.

The surface is ornamented with narrow sharp ribs, increasing by interpolation. The ribs are divided by interspaces which are considerably broader than the ribs. In the interspaces there is frequently seen a lower, threadlike rib. The number of ribs is 30 to 36. The ribs are mostly very distinct on the internal casts also. Sometimes internal casts are found which show remarkably few ribs, and which in this respect and also in their greater breadth approach *Orthis perpasta* var. *macra*.

The present species has thus far been called, after Kusta's example, *Orthis romingeri*, but it differs from that species (a) in the ventral valve, its apex never being so strongly curved as in *Orthis romingeri*, and in most cases not curved at all; (b) in the dorsal valve, which in the present species is more strongly arched with a more decided sinus; (c) in the sculpture, inasmuch as the ribs are narrower, sharper, fewer in number, and separated by wider interspaces than in *Orthis romingeri* Barrande.

Observations.—In the material of this species sent me by Doctor Pompeckj there is one cast of a ventral valve that shows that a convex deltidium covered about two-thirds of the delthyrium; its front margin was arched so as to leave considerable space open between it and the plane of the hinge line.

There is a decided mesial sinus in most specimens of the dorsal valve, but in some it is flattened so as scarcely to break the uniform low convexity of the valve; the strength of the mesial elevation of the ventral valve also varies from a marked ridge to a flattened median space.

The species appears to be quite distinct from any described Cambrian form.

The specific name was given in honor of Mr. Wilhelm Kuthan, of Tejřovik, Bohemia, Austria-Hungary.

Formation and locality.—**Lower Cambrian:** Conglomeratic sandstones and graywacke inclusions in the lower conglomerate zone of the Kamenná hůrka at the following localities [Pompeckj, 1896b, p. 514]: (**345i**)[a] *near Tejřovik*, and (**345j**) at Gross Lohovic, southwest of Skrej; both in Bohemia, Austria-Hungary.

(**345k**)[a] Sandstones at Slapnicky mlýn, near Skrej, Bohemia, Austria-Hungary.

Nisusia (Jamesella) lowi Walcott.

Text figures 61A–D, page 734.

Nisusia (Jamesella) lowi Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 98, Pl. IX, fig. 14. (Characterized and discussed essentially as below as a new species. Fig. 14 is copied in this monograph as fig. 61A.)

The description of the form, outline, convexity, and cardinal area of the ventral valve of *Nisusia festinata* (Billings) (Pl. C, figs. 1, 1a–e) is so applicable to this species that I will refer the student to it for the description of those features. The surface of *Nisusia (Jamesella) lowi* differs from that of *N. festinata* in having more and finer radiating ribs, clearly defined, rounded, concentric striæ and lines of growth, and in the absence of all traces of the surface spines so characteristic of *N. festinata*. The latter is also a larger species. *Nisusia (Jamesella) lowi* averages 10 to 12 mm. across the hinge line and rarely over 8 mm. in the length of the ventral valve of the large shells of the species.

There is a close relationship between *Nisusia alberta* (Walcott) (Pl. C. figs. 3, 3a–d) and *N. (J.) lowi* in form and size. *N. alberta* has a spinose surface, and the beds in which the two species occur are separated by 1,700 feet of limestone.

[a] Localities **345i** and **345k** are represented in the collections of the United States National Museum.

The specific name is given in honor of Hon. A. P. Low, deputy head and director of the Geological Survey of Canada.

Nisusia (Jamesella) lowi occurs at horizons 186 to 294 feet (56.7 to 89.6 m.) above the horizon of *Nisusia festinata* (Billings) in the Mount Stephen section.

FORMATION AND LOCALITY.—**Lower Cambrian:** (**58k**) *Just below the Middle Cambrian in limestones forming 1 of the Mount Whyte formation* [*Walcott, 1908c, p. 240 (9)*], *just above the tunnel;* (**58p**) drift block of limestone believed to have come from the limestone forming 1 of the Mount Whyte formation [Walcott, 1908c, p. 240 (9)], found near the

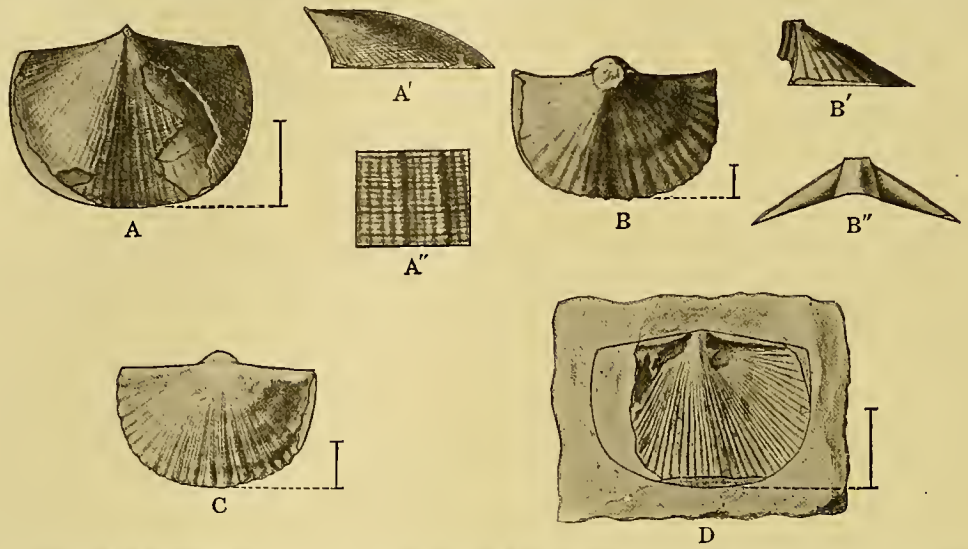

FIGURE 61.—*Nisusia (Jamesella) lowi* Walcott.—A, A′, A″, Top, side, and enlarged view (×9) of exterior surface of a partly exfoliated ventral valve, the type specimen, in limestone (U. S. Nat. Mus. Cat. No. 53677a). B, B′, B″, Top, side, and back views of cast of the interior of a ventral valve, in limestone (U. S. Nat. Mus. Cat. No. 53677b). C, View of the cast of the interior of a small dorsal valve, in limestone (U. S. Nat. Mus. Cat. No. 53677c). D, A compressed dorsal valve in siliceous shale (U. S. Nat. Mus. Cat. No. 57072a).

The specimens represented by figures 61A, 61B, and 61C are from Locality **58k**, and that represented by 61D is from Locality **57m**, both in the Lower Cambrian on Mount Stephen, British Columbia. Figure 61A is copied from Walcott [1908d, Pl. VIII, fig. 14].

Canadian Pacific Railway just west of the tunnel; and (**57m**) about 50 feet (15.2 m.) below the Middle Cambrian in a siliceous shale correlated with 1b of the Mount Whyte formation on Mount Bosworth [Walcott, 1908f, p. 213], just above the tunnel; all on the north shoulder of Mount Stephen, 3 miles (4.8 km.) east of Field, British Columbia, Canada.

(**57s**) About 160 feet (49 m.) below the Middle Cambrian near the base of the gray oolitic limestone forming 1b of the Mount Whyte formation [Walcott, 1908f, p. 212], on Mount Bosworth, north of the Canadian Pacific Railway between Hector and Stephen, on the Continental Divide between British Columbia and Alberta, Canada.

NISUSIA (JAMESELLA) NAUTES (Walcott).

Plate XCIII, figures 6, 6a–b.

Protorthis nautes WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 283–284. (Characterized and discussed somewhat as below as a new species.)

This species has the same type of punctate interior surface as *N. (J.) spencei*, and casts of the exterior are marked by minute, closely set papillæ that are casts of the punctæ in the shell. Traces of the shell show the same type of papillæ and it is highly probable that the shell was punctate. The exterior form is like that of *Nisusia alberta*, but in the surface ribs it differs from the latter and other described species of the genus.

A ventral valve has a length of 5 mm.; width, 8 mm. A dorsal valve, length, 7 mm.; width, 10 mm. There is considerable variation in the relative proportions between length and width.

FORMATION AND LOCALITY—**Middle Cambrian:** (**55c** and **163**)[a] Spence shale member of the Ute limestone [Walcott, 1908a, p. 8], about 50 feet (15.2 m.) above the Brigham quartzite, and 2,755 feet (839.7 m.) below the Upper Cambrian, in a ravine running up into Danish Flat from Mill Canyon, about 6 miles (9.6 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho.

[a] **163** is the type locality.

Specimens that are somewhat doubtfully referred to *Nisusia* (*Jamesella*) *nautes* occur at the following localities:

(15c) Limestone in the Marjum limestone, near Swasey Spring; and (11q) about 2,350 feet (716.3 m.) above the Lower Cambrian, and 2,050 feet (624.8 m.) below the Upper Cambrian in the limestone forming 1c of the Marjum limestone [Walcott, 1908f, p. 180] ridge east of Wheeler Amphitheater; both in the House Range [Walcott, 1908f, Pls. XIII and XV], Millard County, Utah.

(57f) About 2,200 feet (670.6 m.) above the Lower Cambrian, and 2,800 feet (853.4 m.) below the Upper Cambrian, in the limestone forming 1 of the Stephen formation [Walcott, 1908f, p. 209], about 0.5 mile (0.8 km.) east of the "fossil bed," on the northwest slope of Mount Stephen, above Field, on the Canadian Pacific Railway, British Columbia, Canada.

Nisusia (Jamesella) pellico (de Verneuil and Barrande).

Plate XCVII, figures 2, 2a–b.

Orthisina pellico de Verneuil and Barrande, 1860, Bull. Soc. géol. France, 2d ser., vol. 17, pp. 535–536, Pl. VIII, figs. 7, 7a–b. (Described and discussed in French as a new species; see below for translation. Figs. 7, 7a–b are copied in this monograph, Pl. XCVII, figs. 2, 2a–b, respectively.)

The original description by de Verneuil and Barrande follows:

Shell rather small, transverse, breadth greater than length by one-fourth, cut off squarely at the extremities. Hinge crest attains the greatest breadth of the shell. Ventral valve twice as deep as dorsal valve, provided with an area of twice the height, which rises perpendicularly and forms a right angle with the hinge crest. The opening is only partly covered with a deltidium, which descends from the tip of the beak. On the other valve the bare rudiments of a similar deltidium may be perceived.

Neither valve has a sinus, and their commissure presents no wavy contours.

The surface is ornamented with rather wide-spaced striæ. Three or four principal striæ are counted on the sides, and two or three intermediate finer ones. The median region is bounded by two pronounced striæ, between which two or three fainter ones are distinguished.

Dimensions: Breadth, 11 mm.; length, 8 mm.; thickness, 5 mm.

Relations and differences: In having its area partly covered with a deltidium this species comes within the genus *Orthisina*, as understood by Mr. Davidson, but it no longer shows the needle-shaped hole of the tip, on which d'Orbigny had established the genus. However, the analogy which it maintains with the preceding species does not admit of its being placed in any other genus, and shows how slight is the importance of the characteristic used by the author just named. The position of the area, with regard to the hinge, recalls *O. adscendens*, which is clearly distinguished from our species by the nature of its striæ.

From this last-named point of view *O. pellico* approaches the Leptænæ more than it does most of the other *Orthis* or *Orthisina* species.

Observations.—As far as the illustrations and description can determine, this species belongs with the nonspinose forms of *Nisusia* grouped under the subgenus *Jamesella.*

The authors of the species state [1860, p. 536] that this shell was found in the red limestone with their "*Orthis primordialis.*"

Formation and locality.—**Middle Cambrian:** (350 [de Verneuil and Barrande, 1860, p. 538]) Red limestone of the *Paradoxides* zone, near Adrados, north of Sabero and Boñar, Cantabrian Mountains, Province of Leon, northwestern Spain.

Nisusia (Jamesella) perpasta (Pompeckj).

Plate CI, figures 1, 1a–h.

Orthis perpasta Pompeckj, 1896, Jahrb. K.-k. geol. Reichsanstalt, Bd. 45, pp. 515–516, Pl. XV, figs. 15–18. (Described and discussed in German as a new species; see below for translation. Fig. 16d is copied in this monograph, Pl. CI, fig. 1g.)

Nisusia (*Jamesella*) *perpasta* Pompeckj, Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 254–255. (Original description, Pompeckj, 1896, pp. 515–516, copied, and species discussed as essentially on p. 736.)

The original description by Pompeckj follows:

Outline subrectangular, with straight hinge line and slightly bent frontal margin; cardinal angles slightly drawn in; the length is little more than half the breadth, the greatest breadth being in the middle of the valves. Both valves are very strongly arched.

The ventral valve has a high, steep area, with a large triangular foramen, and the areal edges are rather sharp. The apex is not drawn forward beyond the hinge line. From the apex to the frontal edge there is a sinus which gradually increases to a considerable breadth. The dorsal valve, which is also strongly arched, has a very low and

indistinct area, with a low, broadly triangular foramen. On the frontal margin a strong, broad swelling of the edge of the valve corresponds to the sinus of the ventral valve.

Judging by some internal casts and impressions, the shell is ornamented with some 40 broad ribs, of which about half are inserted between the primary ribs at various distances from the apex. Concentric lines of growth cross the ribs. On the top of the shells, along some of these lines of growth (1 or 2) the sections of the shell are found to be imbricated; near the frontal edge such imbrication is present more frequently in very short intervals.

Orthis perpasta differs from *Orthis kuthani* in its greater breadth, in the almost uniform and much stronger arching of both valves, and also in the fact that in the former species the ventral valve bears a sinus, whereas in *Orthis kuthani* the sinus is on the dorsal valve.

Observations.—Doctor Pompeckj very kindly sent me several fragments of sandstone containing casts of the interior and exterior of the valves. The specimens illustrated by Pompeckj [1896b, Pl. XV] are smoother than most of those sent to me, but the description corresponds to the ribbed specimens and a few nearly smooth interior casts occur in association with the more strongly ribbed shells. The convexity of the ventral valve is quite variable, but is usually considerable. One of the marked characters of the dorsal valve is the large transverse space (pseudocruralium) inside the valve beneath the umbo. In one example it is crossed vertically by the main vascular sinuses. What may be a trace of a low, simple, rounded cardinal process is shown in one cast. The crura were strong, with small dental sockets beside them.

Nisusia (Jamesella) perpasta resembles *Nisusia alberta* (Walcott) in form and convexity, but it does not have a spinose surface.

Formation and locality.[a]—**Lower Cambrian**: Conglomeratic sandstones and graywacke inclusions in the lower conglomerate zone of the Kamenná hůrka at the following localities [Pompeckj, 1896b, p. 516]: (**345i**) *near Tejřovik;* and (**345j**) at Gross Lohovic, southwest of Skrej; both in Bohemia, Austria-Hungary.

(**345k**) Sandstones at Slapnicky mlýn, near Skrej, Bohemia, Austria-Hungary.

Nisusia (Jamesella) perpasta macra (Pompeckj).

Plate CI, figures 3, 3a.

Orthis perpasta macra Pompeckj, 1896, Jahrb. K.-k. geol. Reichsanstalt, Bd. 45, p. 516, Pl. XV, fig. 14. (Characterized in German as a new variety; see below for translation. Fig. 14 is copied in this monograph, Pl. CI, fig. 3a.)

Nisusia (Jamesella) perpasta macra Pompeckj, Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 255. (Original characterization copied and variety discussed as below.)

The original description by Pompeckj follows:

Some internal casts and impressions of dorsal valves agree in outline perfectly with the dorsal valves of *Orthis perpastc*, but differ from the type form by much less arching and ribs farther apart.

Observations.—The gradual increase in the width of the interspaces between the ribs, from a very narrow space to several times the width of the rib, makes this variety of doubtful value.

Formation and locality.—**Lower Cambrian**: Conglomeratic, quartzitic sandstones and graywacke inclusions in the zone of the Kamenná hůrka at the following localities [Pompeckj, 1896b, p. 516]: (**345i**) *near Tejřovik;* and (**345j**) at Gross Lohovic, southwest of Skrej; both in Bohemia, Austria-Hungary.

Nisusia (Jamesella) perpasta subquadrata (Pompeckj).

Plate CI, figures 2, 2a–b.

Orthis perpasta subquadrata Pompeckj, 1896, Jahrb. K.-k. geol. Reichsanstalt, Bd. 45, p. 516, Pl. XV, figs. 19 and 20. (Described and discussed in German as a new variety; see below for translation. Figs. 19a and 20a are copied in this monograph, Pl. CI, figs. 2a and 2b, respectively.)

Nisusia (Jamesella) perpasta subquadrata Pompeckj, Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 255. (Original description copied, and variety discussed as on p. 737.)

The original description by Pompeckj follows:

As compared with the type form, this variety is distinguished by less breadth, the length being to the breadth as 3 to 4. The anterior angles of the straight hinge edge are drawn in somewhat more than those of *Orthis perpasta.* The ventral valve is higher, with higher and steep area, pierced by a large triangular foramen. The sinus, which

[a] Localities **345i** and **345k** are represented in the collections of the United States National Museum.

extends from the high vertical apex to the frontal edge, is bordered by obtusely rounded edges. Dorsal valve proportionally more bulged than in the type form. Sculpture as in *Orthis perpasta*.

The outer form strikingly recalls *Orthisina;* but the pseudodeltidium, the median septum, and the spondylium of the ventral valve are lacking.

Orthis perpasta var. *subquadrata* was found in several internal casts and impressions, together with *Orthis perpasta*, more rarely in graywacke sandstone than in the conglomerate-like, quartzitic sandstone.

Observations.—This variety apparently is not constant, as ventral valves occur in the material before me that have the subquadrate form with relatively less convexity than the convex forms of the species *perpasta*.

FORMATION AND LOCALITY.—**Lower Cambrian:** Conglomeratic sandstones and graywacke inclusions in the lower conglomerate zone of the Kamenná hůrka at the following localities [Pompeckj, 1896b, p. 516]: (**345i**) *near Tejřovik;* and (**345j**) at Gross Lohovic, southwest of Skrej; both in Bohemia, Austria-Hungary.

NISUSIA (JAMESELLA) SPENCEI (Walcott).

Text figure 62; Plate XCIII, figures 7, 7a.

Protorthis spencei WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 285. (Described as below as a new species.)

This is a strongly marked species, despite the fact that the few specimens that have been found are flattened in the shale. It is distinguished by its rounded, subquadrate outlines and narrow, sharp ribs with strong interspaces, six ribs in a distance of 5 mm. at the front margin. The area of the ventral valve has a broad delthyrium with a convex deltidium covering the greater part of it. The interior surface of the shell is finely punctate. A flattened ventral valve has a length of 17 mm.; width, 18 mm.

This shell is associated with *Nisusia (Jamesella) nautes* (Walcott). It differs from it in its larger size, sharper ribs, and broader interspaces between the ribs.

The discovery in the collection of 1907 of a specimen of a ventral valve showing a very perfect area and arched deltidium proves that the specimen upon which the reference to *Protorthis* was based had the deltidium crushed so that it was concave, thus causing it to be mistaken for the free spondylium of *Protorthis*.

The specific name is given in honor of Mr. R. S. Spence, of Evanston, Wyoming.

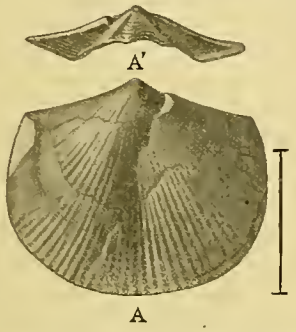

FIGURE 62.—*Nisusia (Jamesella) spencei* (Walcott). A, A', Exterior of ventral valve and view of cardinal area.

The specimen represented is from Locality **55c**, Middle Cambrian Spence shale, near Liberty, Bear Lake County, Idaho (U. S. Nat. Mus. Cat. No. 52435a).

FORMATION AND LOCALITY.—**Middle Cambrian:** (**55c** and **163**)[a] *Spence shale member of the Ute limestone* [*Walcott, 1908a, p. 8*], *about 50 feet (15.2 m.) above the Brigham quartzite and 2,755 feet (839.7 m.) below the Upper Cambrian, in a ravine running up into Danish Flat from Mill Canyon, about 6 miles (9.6 km.) west-southwest of Liberty and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho.*

(**11q**) About 2,350 feet (716.3 m.) above the Lower Cambrian and 2,050 feet (624.8 m.) below the Upper Cambrian in the limestone forming 1c of the Marjum limestone [Walcott, 1908f, p. 180], ridge east of Wheeler Amphitheater [Walcott, 1908f, Pls. XIII and XV], House Range, Millard County, Utah.

NISUSIA (JAMESELLA) UTAHENSIS Walcott.

Plate CI, figures 10, 10a.

Nisusia (Jamesella) utahensis WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 255–256. (Described and discussed as below as a new species.)

Ventral valve transverse, strongly convex; most elevated at the umbo, which is surmounted by the upward pointing apex at the edge of the area; area slightly inclined forward from the hinge line; delthyrium large and covered by a convex deltidium. Surface marked by several strong, rounded ribs irregularly alternating with smaller ribs; fine radiating striæ occur on the ribs and interspaces.

[a] **163** is the type locality.

Only two specimens of somewhat imperfect ventral valves are known of this species. The description is of the best-preserved specimen. The second specimen has a greater number of more regular ribs that increase by interpolation of short ribs. The specimen illustrated has a width of 8 mm. and a length of 4.5 mm. from the apex to the front margin, which is about the distance from the hinge line to the front margin.

The nearest related species is *Nisusia alberta* (Walcott), from which it differs in surface ribs. forward inclination of the area, and prominent convex deltidium.

FORMATION AND LOCALITY.—**Middle Cambrian**: (7w) Limestone in Rock Canyon, in the Wasatch Mountains east of Provo, Utah County, Utah.

NISUSIA (JAMESELLA) sp. undt. Walcott

Nisusia (*Jamesella*) sp. undt., WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 256. (Characterized as below as an undetermined species.)

This doubtful species is based on an interior cast of a broken ventral valve. The width of the shell is 15 mm., and length 8 mm., with apex broken off. A broad, shallow sinus arches the frontal margin, and narrows toward the umbo. Radiating ribs narrow, about five in a space of 2 mm.

FORMATION AND LOCALITY.—**Lower Cambrian**: (392a) Limestone at L'Anse au Loup, on the north shore of the Straits of Belleisle, Labrador.

Genus PROTORTHIS Hall and Clarke.[a]

[*πρό*, early; and Orthis.]

Protorthis HALL and CLARKE, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, pp. 273–274. (Described as in first two paragraphs below.)

Protorthis HALL and CLARKE, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, pp. 589–590. (Copy of preceding reference.)

Kutorgina HALL and CLARKE [not WALCOTT], 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 90–94. (Copies Walcott's description, 1886b, pp. 101–102, and discusses genus, but description and discussion also include reference to specimens now referred to *Protorthis*, *Billingsella*, *Micromitra*, *Micromitra* (*Paterina*), and *Micromitra* (*Iphidella*).)

Protorthis HALL and CLARKE, 1892, idem, pp. 231–233. (Described and discussed as a new genus. With two omissions this reference is copied below.)

Billingsella Hall and Clarke, SCHUCHERT (in part), 1897, Bull. U. S. Geol. Survey No. 87, p. 158. (Characterized and discussed. The genus *Protorthis* is placed as a synonym of *Billingsella*, and among the species referred to the latter genus are species belonging with both *Protorthis* and *Nisusia*.)

Protorthis Hall and Clarke, WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 280–281. (Copies Hall and Clarke, 1892c, pp. 231–233, and discusses genus as on p. 739.)

Protorthis Hall and Clarke, GRABAU and SHIMER, 1907, North American Index Fossils, vol. 1, p. 211. (Characterized.)

Protorthis Hall and Clarke, WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 147. (Classification of genus.)

Hall and Clarke [1892c, pp. 231–233] described the species as follows:

Shells small, transversely subquadrate or semicircular. Hinge line straight, its length being equal to the greatest width of the valves. Valves unequally biconvex, or subplanoconvex, the pedicle valve being the larger. The cardinal area is narrow on both valves, but is higher on the (ventral) pedicle valve, and is transected by a broad delthyrium which is closed below by a concave plate apparently produced by the union of the dental lamellæ, which are not continued to the bottom of the valve; teeth distinctly developed. In the brachial (dorsal) valve the cardinal area also bears an open delthyrium; the dental sockets are obscure and the crural plates small; the latter appear to unite and form a low elevation across the base of the delthyrium. Cardinal process absent or rudimentary in all the specimens examined. Muscular markings in both valves extremely obscure.

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[a] The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Protorthis* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record for the species taken up in the monograph the following mere generic references are listed:

Orthis Hartt [1868, p. 644; 1878, p. 644].
Orthis Walcott [1884a, p. 17].
Kutorgina Matthew [1886, p. 42].
Orthis Matthew [1886, p. 43].
Orthis Hartt [1891, p. 644].
Orthisina? Matthew [1891, p. 131].
Orthis (*Protorthis*) Wysogórski [1900, p. 227].
Protorthis (*Billingsella*) Grabau and Shimer [1907, p. 211].

Surface marked by distinct plications, with interstitial finer radii, which are crossed by delicate concentric striæ; these are usually accompanied by a low sinus and fold on the brachial and pedicle valves, respectively; interior very finely papillose. Shell substance fibrous and apparently punctate.[a]

The characters of the St. John species are eminently comprehensive; first, the form of the shell is one more frequently met with among the strophomenids than among the orthids; the concave plate formed by the union of the dental lamellæ is never found in *Orthis* proper, though occurring in *Scenidium*. In *Orthisina* or *Clitambonites* this plate is always present, but always supported by a median septum and invariably accompanied by the convex deltidium, which, so far as known, does not exist in *Protorthis;* while in the group typified by *Orthis pepina* Hall (here designated by the term *Billingsella*), the convex deltidium of *Clitambonites* is present and the concave or dental plate absent. The apparent absence of a cardinal process in *Protorthis* may be due to the imperfections of the fragile shells studied. The specimens of the St. John shells are preserved as external and internal casts, and from some of these there is reason to infer that the substance of the shell was punctate.

Type.—Orthis billingsi Hartt.

Observations.—A study of the various species here described under the genus *Protorthis* has not given data that will add to the above generic description. All of the species have evidence of punctæ of greater or less depth on the inner and outer surfaces of the shell, but in none of them have punctæ been found that penetrated through the shell; this may be owing largely to the fact that all of the species are preserved as casts in the sandstone or shale and none of them have the original shell substance or a calcareous or siliceous replacement of it.

A careful examination of a large number of specimens of the dorsal valve fails to reveal a true cardinal process.

Protorthis billingsi (Hartt).

Plate XCIX, figures 1, 1a–g.

Orthis billingsi Hartt, 1868, Acadian Geology, by Dawson, 2d ed., pp. 644–645, fig. 223. (Described. The specimen represented by fig. 223 is not figured in this monograph, but it is redrawn by Walcott, 1884a, Pl. I, fig. 1c.)

Orthis billingsi Hartt, 1878, idem, 3d ed., pp. 644–645, fig. 223. (Copy of preceding reference.)

Orthis billingsi Hartt, Walcott, 1884, Bull. U. S. Geol. Survey No. 10, pp. 17–18, Pl. I, figs. 1, 1a–d. (Original description, Hartt, 1868, pp. 644–645, copied and species discussed. None of the specimens represented by figs. 1, 1a–d are figured in this monograph. Fig. 1c is drawn from the specimen figured by Hartt, 1868, p. 644, fig. 223.)

Orthis billingsi Hartt, Matthew, 1886, Trans. Roy. Soc. Canada, 1st ser., vol. 3, sec. 4, No. 4, p. 43. (Discussed.)

Orthis billingsi Hartt, 1891, Acadian Geology, by Dawson, 4th ed., pp. 644–645, fig. 223. (Copy of Hartt, 1868, pp. 644–645.)

Orthisina? billingsi Hartt, Matthew, 1891, Trans. Roy. Soc. Canada, 1st ser., vol. 8, sec. 4, No. 6, p. 131. (Discussed and generic reference changed.)

Protorthis billingsi (Hartt), Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 274, Pl. VIII, figs. 3–7. (Mentioned.)

Protorthis billingsi (Hartt), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 219 and 232, Pl. VIIA, figs. 14–20. (Discussed. Figs. 14–20 are copied from Hall and Clarke, 1892a, Pl. VIII, figs. 5, 7, 3, 4, and 6, respectively.)

Billingsella billingsi (Hartt), Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 158. (Merely changes generic reference.)

Orthis (*Protorthis*) *billingsi* (Hartt), Wysogórski, 1900, Zeitschr. Deutsch. geol. Gesell., Bd. 52, p. 227, footnote. (Discussed in German.)

Protorthis billingsi (Hartt), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 281–282. (Described and discussed as below.)

Protorthis (*Billingsella*) *billingsi* (Hartt), Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 211, fig. 250. (Described. The five figures included in fig. 250 are all copied from Walcott, 1884a, Pl. I, figs. 1, 1a–d.)

The generic description follows very closely that of the type species *Protorthis billingsi* in its main features. All of the specimens are compressed in the embedding shale, which renders it difficult to get a true conception of the convexity and form of the valves. The general form is shown by the illustrations. The outline may be transversely quadrilateral or subsemicircular (Pl. XCIX, figs. 1 and 1e) or subquadrate (figs. 1a–f). Usually the beak is inclined backward over the area, but it may be distorted by pressure so as to appear to incline forward. Young shells have a well-defined median sinus on the ventral valve that shows as a flattened space on the larger shells. A slight sinus sometimes appears on the dorsal valve. The surface of the shell varies in the number and size of the radiating ribs; sometimes they are scarcely visible

[a] The casts of the interior of the valves indicate that the inner layer of the shell is punctate, but I have been unable to obtain any evidence that the shell had the fibrous or punctate structure characteristic of *Dalmanella*.

toward the cardinal margin, and in other shells they are clearly defined all over the surface; the increase in number is by bifurcation and interpolation; fine, threadlike concentric striæ and strong squamose lines of growth cross the ribs.

Ventral valve moderately convex, with the umbo and apex slightly curved over the area (Pl. XCIX, fig. 1), or erect above the area (Pl. XCIX, fig. 1b). The cardinal area appears to be slightly concave; divided midway by a triangular delthyrium, which is more or less closed by a concave plate that Hall and Clarke consider [1892c, p. 231] to be formed by the extension of the dental plates or lamellæ; from the casts it appears that the teeth were well developed and supported by dental plates that united at the center opposite the delthyrium, but did not reach the bottom of the valve or a median septum; the free spondylium varied in length from a narrow rim opposite the head of the delthyrium to a plate two-thirds or more of the length of the delthyrium.

Dorsal valve uniformly and moderately convex, with the apex curved over to the edge of the low area; area divided by a broad delthyrium; casts of the interior show that the cruræ were strong, dental sockets shallow, and that the crural plates extended across the umbonal cavity, uniting to define what may be called a pseudocruralium. No trace of a cardinal process has been seen in a large number of casts of the interior, and Hall and Clarke did not find any in a large amount of material.

The casts of the interior show that the inner layer of the shell was minutely punctate, and a shell preserving some of the inner layers has every appearance of such a structure.

Observations.—This species differs from all recognized species of the genus by its surface ribs and striæ.

The specific name was given in honor of Mr. E. Billings.

Formation and locality.—**Middle Cambrian:** (**2e**) Shale 25 feet (7.6 m.) above the basal quartzite, on Seeley Street, St. John; (**3b**) shale at the base of the *Paradoxides* zone, at the head of Seeley Street, St. John; (**301k**) St. John formation in the city of St. John; (**301g**) sandstones of Division 1c of Matthew, at Portland (now a part of the city o St. John); (**308h** and **308i**) shales in Portland (now a part of the city of St. John); (**301j**) *shales of the St. John formation at Ratcliffs Millstream;* and (**21** and **2m**) limestone at the base of the *Paradoxides* zone [Matthew, 1895a, p. 108], on Hanford Brook; all in St. John County, New Brunswick, Canada.

Protorthis helena Walcott.

Plate XCIX, figures 4, 4a–b.

Protorthis helena Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 282. (Characterized and discussed essentially as below as a new species.)

This species is founded on the cast of a ventral valve associated with *Trematobolus kempanum* (Matthew). The form of the spondylium and area is much like that of *Protorthis latourensis* (Matthew) (Pl. XCIX, figs. 3b and 4b), but the smooth shell with its broad, rounded mesial sinus is unlike that species and also other species of the genus. The shell appears to have been thicker than that of *P. latourensis*. Only traces of growth lines are preserved on the cast. The ventral valve is 10 mm. long, with a width of 14 mm. The cast shows that the teeth and dental plates were unusually strong.

This species differs from all others of the genus by its smooth or nearly smooth surface and strong median sinus. It suggests *Syntrophia barabuensis* (Winchell) at first sight, but there is no evidence of a median septum supporting the spondylium.

The specific name was given for Mrs. Walcott, who collected the specimen.

Formation and locality.—**Middle Cambrian:** (**2u**) Lowest beds exposed on the south side of Long Island, Kennebecasis Bay [Matthew, 1898a, pp. 124 and 127], St. John County, New Brunswick, Canada.

Protorthis? hunnebergensis Walcott.

Plate XCV, figures 5, 5a–c.

Protorthis? nunnebergensis Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 284. (Described and discussed as on p. 741 as a new species. The name "*nunnebergensis*" was used under the impression that the correct spelling of the type locality was Nunneberg; the species occurs on Hunneberg.)

Protorthis? hunnebergensis Walcott, Moberg and Segerberg, 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), pp. 70–71, Pl. II, figs. 5, 5a–c. (Described and discussed. Figs. 5, 5a–c, in common with the remaining figures on Pl. II of Moberg and Segerberg's paper, were copied from a preliminary photograph of Pl. XCV of this monograph.)

Shell transversely semielliptical, plano-convex. Surface with very fine ribs that increase by interpolation and bifurcation; on some shells bands of slender ribs are delimited by stronger ribs, usually 2 to 5, between 2 more prominent ribs; fine concentric striæ give a crenulated aspect to the radiating ribs. Casts of the interior and exterior appear to be minutely papillose, indicating punctæ in the shell.

Ventral valve moderately convex, with the apex curved down to the margin of the area; area and interior unknown. Dorsal valve flat or very slightly concave between the umbo and margins; apex slightly elevated above the plane of the surface and cardinal line; a median sinus is present in some shells.

Observations.—It is a little hazardous to refer this species to *Protorthis*, as only the general form and surface are known. The nearly plano-convex valves and surface relate it more nearly to *Protorthis* than to *Plectorthis*, and it does not appear to fall within *Leptæna*, *Rafinesquina*, or *Strophomena*. The specimens were collected by Mr. Schmalensee in a dark, argillaceous shale above the *Ceratopyge* limestone and below the lower graptolite shale.

The specific name is derived from Hunneberg, Sweden.

Formation and locality.—**Passage beds** between the Upper Cambrian and the Ordovician: (**390f**) Shales between the "lower graptolite slate" and the *Ceratopyge* limestone, at Mossebo, on Hunneberg, western boundary of the Province of Skaraborg, Sweden.

Protorthis lævis Walcott.

Plate XCIX, figures 6, 6a–b.

Protorthis lævis Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 283. (Described and discussed as below as a new species.)

Ventral valve transversely semicircular, moderately convex; surface of cast smooth; area overhanging the hinge line at about 30° from the plane of the margin of the valve. The cast shows a very clearly defined free spondylium. Shell about 6 mm. in width and 4 mm. in length.

This is one of the few representatives of the genus known outside of the Atlantic basin Cambrian fauna. Its smooth surface and inclined area distinguish it from other species of the genus.

Formation and locality.—**Upper Cambrian**: (**79a**) "St. Croix sandstone" in a quarry and ledge 0.5 mile (0.8 km.) southeast of the county courthouse, Menomouie, Dunn County, Wisconsin.

Protorthis latourensis (Matthew).

Plate XCIX, figures 3, 3a–d.

Kutorgina latourensis Matthew, 1886, Trans. Roy. Soc. Canada, vol. 3, sec. 4, No. 4, pp. 42–43, Pl. V, figs. 18, 18a–c. (Described and discussed. None of the specimens represented by figs. 18, 18a–c are figured in this monograph.)

Kutorgina latourensis (Matthew), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 93, 95, and 233, Pl. IV, figs. 18–20. (Discussed.)

Protorthis latourensis (Matthew), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 282–283. (Original description, Matthew, 1886, pp. 42–43, copied, and species discussed as on p. 742.)

The original description by Matthew follows:

Valves narrowly semicircular, broader than long, flat; umbones low; greatest thickness in the posterior third; hinge line shorter than the width of the shell.

Dorsal valve with a distinct median depression extending from the umbo to the front margin, and with low ridges diverging from the beak toward the lateral third of the front of the valve. Umbo not elevated above the hinge area, which is exceedingly narrow or absent. Hinge line with two sharp slightly projecting teeth near the umbo (crura?).

Ventral valve with a narrow median ridge extending two-thirds of the length of the valve toward the front margin; also with a fainter ridge on each side diverging toward the lateral third of the border of the valve; umbo very

low; hinge area perceptible, but very narrow, longitudinally striated, and having a minute tooth on each side of the very narrow and small foraminal opening.

Surface ornamented with about forty or fifty fine, faint, radiating striæ; those of the middle fifth are close, continuous, and straight; a few on each side of these are divergent, while those near the back of the shell are fainter, closer than the last, and moderately arched outward toward the lateral borders. The surface of the valves is also marked by very fine but distinct concentric striæ, and at somewhat regular intervals by about twelve more distinct lines of growth. The concentric striæ are usually as distinct as the radiating. Casts of the interior of the valves exhibit a smooth surface with some irregular, sinous, radiating striæ.

Length, 7 mm.; width, 11 mm. Length of hinge line, 8 mm.

Observations.—Doctor Matthew kindly sent me the typical specimens of this species, and from them and specimens in the collections of the United States National Museum sufficient data were obtained to clearly show that the species belongs to *Protorthis* and not *Kutorgina*. In figure 3b, Plate XCIX, the free spondylium is present. As far as known, the characters of the area, teeth, and free spondylium are the same as in *P. billingsi*. The smooth casts suggest *Kutorgina* [Hall and Clarke, 1892c, Pl. IV, figs. 18–20], but the ribbed shells recall *P. quacoensis*, and the area with open delthyrium and free spondylium places the species in *Protorthis*. Its very fine surface ribs differentiate *P. latourensis* from all other described species.

The form described by Matthew [1886, p. 43, Pl. V, fig. 19] as "*Kutorgina pterineoides*" is not taken up in this monograph. The species is represented by one distorted specimen which may not even be a brachiopod.

Formation and locality.—**Middle Cambrian:** (**301w**) *Shales of Division 1c2 of Matthew's section;* (**308h**) shales of Division 1c1 of Matthew's section; and (**301g**) shales of Division 1c of Matthew; all at Portland (now part of the city of St. John), St. John County, New Brunswick.

Protorthis quacoensis (Matthew).

Plate XCIX, figures 2, 2a–e.

Orthis quacoensis Matthew, 1886, Trans. Roy. Soc. Canada, vol. 3, sec. 4, No. 4, pp. 43–44, Pl. V, figs. 20, 20a–c. (Described and discussed. The two specimens represented by figs. 20–20a and 20b–20c are redrawn in this monograph, Pl. XCIX, figs. 2e and 2b, respectively.)

Orthisina? quacoensis Matthew, 1891, Trans. Roy. Soc. Canada, 1st ser., vol. 8, sec. 4, No. 6, p. 131. (Mentioned and generic reference changed.)

Protorthis quacoensis (Matthew), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 232, Pl. VIIA, fig. 21. (Changes generic reference.)

Billingsella quacoensis (Matthew), Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 159. (Merely changes generic reference.)

Protorthis quacoensis (Matthew), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 284–285. (Original description, Matthew, 1886, pp. 43–44, copied and species discussed as below.)

The original description by Matthew follows:

A small species. Subquadrate to semielliptical in outline, broader than long, widest near or at the hinge line, which is not produced; moderately convex, highest in the posterior third, flattened toward the front and sides. Umbones not prominent.

The dorsal valve rises rapidly from the hinge line, and has but a narrow, flattened space at the angles. It is about one-third as high as it is long. The hinge plate has a narrow area, which is striated lengthwise, and bears two tooth-like processes close to the umbo, the point of which is bent down to the hinge line.

The ventral valve is somewhat more elevated than the dorsal. Hinge area triangular, sloping backward to the umbo, and bearing fine striæ parallel to the hinge line. Umbo elevated above the hinge line to a height fully equal to one-third of the length of the valve. Foramen (delthyrium) large, truncate-pyramidal in outline.

Surface of the valves ornamented by about twenty rounded plicæ, radiating (in the ventral valve) from the edge of the hinge area; opposite the foramen (delthyrium) and not from the beak alone; those on the middle fifth of each valve are crowded together; those outside of these are more prominent, and are continuous from the umbo; those toward the hinge line are faintly marked and widely separated. The radiating plicæ do not (or rarely) increase by bifurcation. Both valves bear numerous concentric striæ and are also marked by a few distinct squamose lines of growth.

The mold or cast of the interior of the valves of this species is nearly smooth, or is marked by faint radiating striæ; the margin of the mold, however, often exhibits a crenulated appearance corresponding to the plicæ of the outer surface. There is a wide, smooth median depression at the top of the mold of the dorsal valve, near the umbo.

Length of the valve in *O. quacoensis*, 5 mm.; width, 8 mm.

Observations.—Doctor Matthew very kindly sent me his types of this species and I have had a number of drawings made from them. A glance at them and the illustrations of *P. billingsi* shows that the two species are quite distinct and that *P. quacoensis* is unlike any other shell referred to the genus.

As far as seen, the free spondylium of the ventral valve is short; the teeth are clearly shown in the cast. The pseudocruralium of the dorsal valve is much more clearly defined than in *P. billingsi* (pc, Pl. XCIX, figs. 2c and 2e), the area is higher (Pl. XCIX, fig. 2c), and traces of the adductor muscle scars are preserved (Pl. XCIX, fig. 2d).

FORMATION AND LOCALITY.[a]—**Middle Cambrian**: (**301m** [Matthew, 1886, p. 44]) Shale of Division 1c of Matthew's section on Porters Brook, St. Martins; (**3b**) shale at the base of the *Paradoxides* zone, at the head of Seeley Street, St. John; (**301w**) shales of Division 1c2 of Matthew's section at Portland (now a part of the city of St. John); and (**301g** [Matthew, 1886, p. 44]) sandstones of Division 1c at Portland (now part of the city of St. John); all in St. John County, New Brunswick, Canada.

PROTORTHIS WINGI Walcott.

Plate XCIII, figures 5, 5a–c.

Protorthis wingi WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 286. (Described and discussed as below as a new species.)

General form transversely subelliptical. Surface marked by about 20 sharply ridged ribs, with interspaces equal and usually greater than the width of the rib; shell with numerous small and many larger and scattered punctæ on the inner and outer surfaces. The largest ventral valve has a length of 6 mm.; width, 9 mm.

Ventral valve convex, elevated at the umbo and beak; area high and divided midway by a strong delthyrium, which is partly closed by a concave free spondylium (sp) as in *P. billingsi;* teeth strong, dental plates extended toward the center to unite and form the free spondylium.

Dorsal valve slightly convex, with a broad median sinus that is usually bounded by one or two large ribs; casts of the interior show a narrow area, broad delthyrium, and, opposite the umbo, the cast of a small, broadly triangular, elevated area that probably served as the cardinal process for the attachment of the diductor muscles.

Observations.—This species is most nearly related to *Nisusia* (*Jamesella*) *nautes* (Walcott); it differs, as far as known, in the character of the interior of the dorsal valve, the large punctæ scattered among the fine punctæ, and the sharp-ridged ribs. One cast of an interior of a ventral valve (Pl. XCIII, fig. 5a) appears to indicate that the shell was without the free spondylium; it not infrequently occurs in *Protorthis billingsi* (Hartt) that the free spondylium is reduced to a narrow rim about the margin of the delthyrium and it may be that in this shell it was absent.

The specific name is given in memory of Rev. Augustus Wing, whose extensive and excellent work in the vicinity of Swanton, Vermont, was utilized by Billings and Logan in the reports of the Geological Survey of Canada.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**28**) Shales about 100 feet (30.5 m.) above the *Olenellus* horizon south of Highgate Falls, 0.25 mile (0.4 km.) east of Swanton, Franklin County, Vermont.

PROTORTHIS sp. undt. Walcott.

Protorthis sp. undt., WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 286. (Described and discussed as below as an undetermined species.)

Ventral valve convex, elevated at the umbo, apex incurved. The cast of the umbonal cavity (pseudospondylium) indicates well-developed teeth and dental plates. On the cast six radiating ribs occur in the distance of 1 millimeter; area about vertical. The surface of the cast indicates that the interior layer of the shell was finely punctate. Length of valve 4.5 mm.; width, 5.5 mm.

[a] Matthew does not state which of the two localities, **301g** and **301m**, is the type, though he [1886, p. 82] locates the type specimen (Pl. XCIX, fig. 2b) in Division 1c of his Etcheminian.

Only one specimen of a cast of a ventral valve of this shell was found. It suggests by its convexity and surface some of the more convex forms of *Protorthis quacoensis*

FORMATION AND LOCALITY.—**Upper Cambrian**: (75) Thin-bedded limestone just below the base of the Ordovician, in the Tonto group; near the water's edge at the mouth of Kanab Canyon, Grand Canyon of the Colorado, Arizona.

LOPERIA Walcott, subgenus of PROTORTHIS.

Protorthis (*Loperia*) WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 287. (Characterized as below as a new subgenus.)

Protorthis (*Loperia*) WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 147. (Classification of subgenus.)

This subgenus is characterized by the form of the valves. The ventral valve is elevated at the umbo and flat or slightly concave from the umbo to the margins; the dorsal valve is strongly and regularly convex. The description of the type species, *Protorthis* (*Loperia*) *dugaldensis* Walcott, includes that of the subgenus, as it is the only species thus far known.

The subgeneric name is given in recognition of the effective work of Mr. S. Ward Loper, who collected the material representing this and many other Cambrian fossils in Cape Breton and New Brunswick.

PROTORTHIS (LOPERIA) DUGALDENSIS Walcott.

Plate XCIX, figures 5, 5a–j.

Protorthis (*Loperia*) *dougaldensis* WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 287–288. (Described and discussed as below as a new species.)

General form rounded subquadrate. Hinge line straight and shorter than the greatest width of the shell; cardinal extremities obtusely angular. Relative convexity of the valves reversed as in *Dinorthis pectinella* [Hall and Clarke, 1892c, Pl. V, figs. 28–31] of the Ordovician fauna. Surface of the valves with strong, simple, rounded ribs that increase by interpolation; fine concentric striæ and lines of growth, that sometimes form ridges, cross the ribs, curving in the interspaces and over the ribs; these ribs are more prominent and numerous (30 to 40) on the dorsal than on the ventral valve; on the latter the ribs are broad, with narrow interspaces, and about 20 to 25 in number; casts of the exterior and interior surfaces have numerous fine, thickly set, elevated papillæ that appear as the casts of the punctæ in the layers of the shell; on some specimens the papillæ are cylindrical and elevated, which indicates that they penetrated deep into the shell substance. All indications point to a punctate shell; in all the material representing the species the shell has been removed by solution, only the casts of the inner and outer surfaces remaining.

The largest ventral valve in the collection has a length of 18 mm., width 25 mm.; dorsal valve, length 22 mm., width 27 mm.

Ventral valve elevated at the umbo and gently concave from the umbo to the front margin and flat to the cardinal extremities. Area relatively low and overhanging the hinge line at an angle of about 45°; it is divided midway by a broad delthyrium that is more or less closed by a deeply concave plate, which is crossed by the transverse striæ of growth of the area. The concave plate appears to be identical in form and position with the free spondylium of the genus *Protorthis*. A cast of the interior (fig. 5) shows very strong teeth and supporting dental plates; the edges of the dental plates appear to be continuous with the concave plate or free spondylium.

Dorsal valve strongly and regularly convex, with a slight flattening of the median line and sometimes a shallow sinus. Casts of the interior show a strong area, with a triangular delthyrium; the umbonal cavity is strongly outlined by the crural plates so as to form a pseudocruralium; crura well developed, with clearly defined tooth sockets back of them. No traces of a cardinal process have been seen in ten specimens showing fine casts of the area, delthyrium, and umbonal cavity.

Observations.—This fine species is unique among Cambrian brachiopods in having a depressed, flat, or convex ventral valve and strongly convex dorsal valve; in its punctate

shell, free spondylium and absence of cardinal process, it is allied closely to *Protorthis;* the depressed ventral valve and convex dorsal valve serve to distinguish it as a subgenus of *Protorthis.*

The specific name is derived from Dugald Brook, Cape Breton.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**10p**) *Sandstone just below the waterfall 0.25 mile (0.4 km.) from the lower bridge in Division E2b of Matthew's [1903, p. 21] Etcheminian, Dugald Brook, Indian River, eastern Cape Breton, Nova Scotia.*

(**2u**) Lowest beds exposed on the south side of Long Island, Kennebecasis Bay [Matthew, 1898a, pp. 124 and 127], St. John County, New Brunswick.

Subfamily BILLINGSELLINÆ Schuchert.

Genus WIMANELLA Walcott.

Billingsella WALCOTT (in part) [not HALL and CLARKE], 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 227–229. (Described and discussed as on p. 749 (under *Billingsella*), but several of the species referred to the genus are now placed under *Wimanella.*)

Wimanella WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 98–99. (Discussed somewhat as below as a new genus.)

Wimanella WALCOTT, 1908, idem, vol. 53, No. 4, Pl. XI, and pp. 142 and 148. (Classification of genus.)

This genus is proposed for the smooth nonplicate species that I have heretofore referred to the genus *Billingsella.* The generic description of *Billingsella* includes the characters of *Wimanella* with the exception that the latter is a smooth shell but for the presence of concentric striæ and lines of growth. *Wimanella* represents the smooth, early stages of development and *Billingsella* the later, mature plicate stage of development of this section of the Billingsellidæ.

Type.— *Wimanella simplex* Walcott [1908d, p. 98].

Observations.—It is to be noted that *Billingsella plicatella* Walcott (Pl. LXXXVI, figs. 3g and 3h) includes some shells that are nearly smooth, and that *B. highlandensis* (Walcott) (Pl. LXXXVII, figs. 4 and 4c) is very finely costate. The former species may be considered as being in part a form intermediate between *Billingsella coloradoensis* (Shumard) and *Wimanella harlanensis* (Walcott). I think, however, that the species with smooth shells should be grouped under a generic head, as they indicate a marked phase in the evolution of the forms formerly grouped under *Billingsella.*

The generic name was given in recognition of the valuable work of Dr. Carl Wiman of the University of Upsala, on the geology and paleontology of the Baltic region.

WIMANELLA? ANOMALA (Walcott).

Plate LXXXVII, figures 1, 1a–e.

Billingsella? anomala WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 230. (Described and discussed as below as a new species.)

Shell subquadrilateral, with the dorsal valve transverse. On the ventral valve the cardinal line slopes toward the beak at an angle of from 15° to 20°, while in the dorsal valve it is nearly straight. The greatest width of the valves is about the middle of the shell. Owing to compression and consequent distortion there is considerable variation in the relative proportions of length and breadth. The cardinal angle is acute, in some instances extending out some distance beyond the widest portion of the shell, resembling in this respect the cardinal angles of some of the Strophomenidæ. All of the specimens are so compressed in the shale that little is preserved of their natural convexity. A low, broad, mesial sinus occurs on the dorsal valve, and there is a slight flattening of the anterior central portion of the ventral valve.

The surface is marked by fine, radiating striæ, that are increased in number toward the front by the addition of interstitial striæ, giving a fasciculate appearance to the surface. The radiating striæ are crossed by concentric lines of growth and fine striæ. The surface as described occurs in one specimen, all other specimens being nearly smooth. This, however, may arise

from maceration and flattening out of the surface characters by compression. The interior of the shell appears to have been covered by minute punctæ.

The largest specimen of the collection has a transverse diameter of 14 mm. The average size of the ventral valve is about 8 mm. in height by 8 mm. in width.

Cardinal area about one-fifth the height of the shell. It is marked by transverse striæ of growth that cross it parallel to its base. Delthyrium rather broad. No traces of the deltidium have been observed. Cardinal area of the dorsal valve short. It is divided midway by a strong delthyrium. Nothing is known of the interior characters except the presence of a short crura in the dorsal valve.

Observations.—This shell occurs quite abundantly in the very fine, buff-colored, argillaceous shales of the Coosa Valley Cambrian section. There is some doubt as to its surface characters, as only one specimen found in the same beds has traces of radiating striæ, and these may be from the interior radiating lines. All others appear to be nearly smooth. Its strongest character is the extension of the cardinal angle. Owing to the imperfection of the material the generic reference is doubtful.

The species was anomalous while under *Billingsella*, to which it was first referred, hence the specific name.

Formation and locality.—**Middle Cambrian**: (90) Conasauga ("Coosa") shale, on Edwards farm, near Craigs Mountain, about 10 miles (16.1 km.) southeast of Center, Cherokee County, Alabama.

Wimanella harlanensis (Walcott).

Plate LXXXVII, figures 5, 5a–d.

Billingsella harlanensis Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 236. (Characterized and discussed as below as a new species.)

The general form and convexity of this shell is similar to that of *Billingsella plicatella* Walcott. It differs in having a nearly smooth surface marked only by fine concentric striæ and a few traces of narrow, sharp radiating costæ. The interior of the ventral valve has very strong main vascular sinuses and a deep, sharply defined, tripartite umbonal area opposite the delthyrium; the tripartite area is much like that in *Billingsella coloradoensis* (Shumard) and *B. exporrecta* (Linnarsson). The main vascular sinuses pass directly back across the ridge in front of the tripartite area and occupy the two lateral divisions of the area. The interior of the dorsal valve represented in figure 5a shows an abnormal arrangement of the vascular markings and muscle scars.

The specific name is derived from Harlan Knob, Tennessee.

Formation and locality.—**Middle Cambrian**: (107) Limestone in Bull Run, northwest of Copper Ridge [Keith, 1896b, areal geology sheet], 11 miles (17.6 km.) northwest of Knoxville, Knox County; and (121) *Rogersville shale, road just east of Harlan Knob, 4 miles (6.4 km.) northeast of Rogersville* [*Keith, 1905, areal geology sheet*], *Hawkins County;* both in Tennessee.

Wimanella inyoensis Walcott.

Text figures 63A–B, page 747.

Wimanella inyoensis Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 99, Pl. X, fig. 4. (Described as below as a new species. Fig. 4 is copied in this monograph as fig. 63A.)

This species is represented by numerous specimens in the form of casts in a calcareous sandstone. All of the shells are more or less compressed and distorted. Some of those best preserved indicate that the general outline was transverse. A specimen 6 mm. in length has a width of 7 mm. The two specimens illustrated (figs. 63A and 63B) occur on the same fragment of rock and illustrate fairly well the difference in outline; it may be that figure 63A is the narrow ventral valve and figure 63B the broader dorsal valve.

The most striking feature is the presence of two strong radiating ridges that originate near the beak and extend forward nearly to the frontal margin. These ridges may be the casts of the main vascular sinuses or it may be that they represent ridges on the exterior of the shell, one on each side of the shallow median sinus. At present, with the material before me, I am inclined to the view that they represent the casts of sinuses and hence the provisional generic reference to *Wimanella*.

Nothing is known with certainty of the outer surface or of the substance of the shell. The interior casts and the matrices of the casts show two strong radiating ridges, the shell substance having apparently been removed and its place lost by the compression of the sediment before its consolidation.

The specific name is derived from Inyo County, California.

FORMATION AND LOCALITY.—**Lower Cambrian**: (**8b**) Limestones in Tollgate Canyon, about 15 miles (24.2 km.) east of White Pine, White Mountain Range, Inyo County, California.

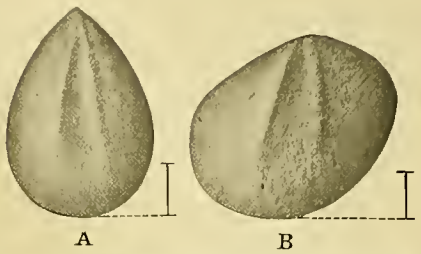

FIGURE 63.—*Wimanella inyoensis* Walcott. A, B, Narrow and broad forms showing the two strong ridges on the cast that are supposed to represent the main vascular sinuses (U. S. Nat. Mus. Cat. Nos. 52255a and 52255b, respectively).

The specimens represented are from Locality **8b**, Lower Cambrian, Inyo County, California. Figure 63A is copied from Walcott [1908d, Pl. X, fig. 4]. It represents the type specimen.

WIMANELLA SAFFORDI (Walcott).

Plate LXXXVII, figures 7, 7a.

Billingsella saffordi WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 244. (Described and discussed as below as a new species.)

General outline of ventral valve subsemicircular and of dorsal valve transversely broad oval; greatest width of valves at about the center; hinge line straight and a little shorter than the greatest width of the shell. A typical ventral valve has a length of 9 mm., width 9 mm. Dorsal valve, length 10 mm., width 12 mm. Biconvex, the ventral valve being more elevated at the umbo than the dorsal. Surface, so far as known, smooth or marked by concentric striæ and lines of growth.

Ventral valve with umbo curving over and terminating in the small apex that incurves a little over the area; area about one-half the elevation of the valve; a broad delthyrium is partly covered by a convex deltidium; casts of the interior indicate a low, tripartite pseudospondylium and one cast shows strong main vascular sinuses extending from the lateral divisions of the pseudospondylium nearly to the front margin. Dorsal valve with low area and small pseudocruralium; the casts are too imperfect to show any other details.

Observations.—This species occurs in the same region as *Wimanella harlanensis* (Walcott) and also has a smooth shell; it differs in being of equal length and breadth and in having less strongly marked interior characters.

The specific name is given in recognition of the work of Mr. J. M. Safford upon the geology of Tennessee.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**14a**) Sandstone of the Rome formation, along First Creek Gap, 4 miles (6.4 km.) north-northeast of Knoxville [Keith, 1905, areal geology sheet], Knox County, Tennessee.

WIMANELLA SHELBYENSIS Walcott.

Plate II, figures 9, 9a.

Wimanella shelbyensis WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 100, Pl. X, fig. 3. (Described and discussed as below as a new species. Fig. 3 is copied in this monograph, Pl. II, fig. 9.)

All the specimens representing this species in the collection are flattened in the shale to such an extent that very little of the original convexity of the shell is retained, and only the impression of the shell remains, as the shell substance has been entirely removed, probably by solution. The general form of this species resembles very closely that of *Billingsella? appalachia*.

The casts show a strong cardinal area on the ventral valve, with a broad delthyrium, but not a pseudodeltidium; the dorsal valve has a narrow cardinal area with a broad open delthyrium.

The exterior surface is marked by fine concentric lines and a few stronger varices of growth. A small ventral valve has a length of 8 mm., with a width of 10 mm. A larger one has a length of 18 mm.; width, 22 mm. A small dorsal valve has a length of 10 mm.; width, 13 mm.; and the largest dorsal valve in the collection has a length of 19 mm.; width, 25 mm.

None of the specimens show any traces of vascular or muscular markings; in this respect resembling *Wimanella? anomala* (Walcott) (Pl. LXXXVII) and *Billingsella? appalachia* Walcott (Pl. LXXXVII).

This species appears to be the Lower Cambrian representative of *W.? anomala* of the Middle Cambrian, differing from the latter in having rounded cardinal angles instead of the acute projecting angles so characteristic of *W.? anomala*. *Billingsella? appalachia* has the same general form as *W. shelbyensis*, but the latter differs from it in having a smooth surface and in the absence of all traces of radiating ribs.

It more nearly resembles *Wimanella simplex* Walcott (Pl. LXXXIX, fig. 2). It differs from the latter in being more transverse, and the cast of the umbonal cavity is relatively smaller.

It is a curious fact that in all the species of *Wimanella* mentioned there is no trace of a vascular marking or muscle scar. All the species occur in argillaceous shale, and none of them preserve the shell substance. The shells appear to have been macerated and removed by solution, leaving only a cast of the compressed inner or outer surface of the valve.

The specific name is derived from Shelby County, Alabama.

FORMATION AND LOCALITY.—**Lower Cambrian**: (**17b**) *Shale in Rome ("Montevallo") formation, 4 miles (6.4 km.) south of Helena;* and (**56c**) shale in Rome ("Montevallo") formation along road just north of Buck Creek, 1.125 miles (1.8 km.) northeast of Helena; both in Shelby County, Alabama.

WIMANELLA SIMPLEX Walcott.

Text figure 64; Plate LXXXIX, figures 2, 2a–e.

Wimanella simplex WALCOTT, 1908f, Smithsonian Misc. Coll., vol. 53, No. 3, p. 101, Pl. X, fig. 2. (Discussed as below as a new species. Fig. 2 is copied in this monograph, Pl. LXXXIX, fig. 2.)

The general form of this species is much like that of *Billingsella coloradoensis*, except that the beak of the ventral valve rises above the hinge line, much as in *B. highlandensis* (Pl. LXXXVII, figs. 4, 4a). The surface of *W. simplex* appears to be smooth except for a few concentric lines of growth. Nothing is known of the interior except what is shown by the cast of the umbonal cavity. A crushed specimen with the two valves flattened out (fig. 2e) indicates that the beak of the dorsal valve was slightly elevated above the hinge line; it is probable that figure 2 represents a dorsal valve. All the specimens are flattened in shale, and the shell substance has been removed by solution. The material is unsatisfactory, but as it represents a species of the smooth type from a known horizon in the Middle Cambrian, it is illustrated and given a specific name.

FIGURE 64.— *Wimanella simplex* Walcott. Interior of a compressed dorsal valve. Found in Locality **35c**, in a drift block of Lower Cambrian shale on Mount Bosworth, British Columbia (U. S. Nat. Mus. Cat. No. 51407).

FORMATION AND LOCALITY.—**Lower Cambrian**: (**4v**) *About 200 feet (61 m.) above the unconformable base of the Cambrian and 75 feet (22.9 m.) above the top of the quartzitic sandstones in a shale which corresponds in stratigraphic position to shale No. 6 of the Dearborn River section [Walcott, 1908f, p. 202], Gordon Creek, 6 miles (9.6 km.) from South Fork of Flathead River;* and (**4q** and **4w**) about 315 feet (96 m.) above the unconformable base of the Cambrian and 190 feet (57.9 m.) above the top of the quartzitic sandstones in a shale which corresponds in stratigraphic position to shale No. 6 of the Dearborn River section [Walcott, 1908f, p. 202], on Youngs Creek, about 5 miles (8 km.) from its junction with Danaher Creek; both in the Ovando quadrangle (U. S. Geol. Survey), Powell County, Montana.

(**35c**) Drift blocks of siliceous shale supposed to have come from the Mount Whyte formation [Walcott, 1908f, p. 214], found on the south slope of Mount Bosworth, a short distance northwest of the Canadian Pacific Railway track between Stephen and Hector, eastern British Columbia, Canada.

Genus BILLINGSELLA Hall and Clarke.[a]

Billingsella Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, p. 273. (Described.)

Billingsella Hall and Clarke, 1892, Forty-fifth Ann. Rept. New York State Museum for 1891, p. 589. (Copy of preceding reference.)

Kutorgina Hall and Clarke [not Walcott], 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 90–94. (Copies Walcott's description, 1886b, pp. 101–102, and discusses genus, but description and discussion also include reference to specimens now referred to *Billingsella*, *Protorthis*, *Micromitra*, *Micromitra* (*Paterina*), and *Micromitra* (*Iphidella*).)

Billingsella Hall and Clarke (in part), 1892, idem, pp. 230–231. (Described and discussed as a new genus. The genus as described also included species now referred to *Nisusia*.)

Billingsella Hall and Clarke, Schuchert (in part), 1897, Bull. U. S. Geol. Survey No. 87, p. 158. (Characterized and discussed. The genus *Protorthis* is placed as a synonym of *Billingsella*, and among the species referred to the latter genus are species belonging with both *Protorthis* and *Nisusia*.)

Billingsella Hall and Clarke, Walcott (in part), 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 227–229. (Described and discussed essentially as below. Species that are now referred to *Wimanella* were included in the genus.)

Billingsella Hall and Clarke, Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 210. (Described.)

Billingsella Hall and Clarke, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 148. (Classification of genus.)

Shell subquadrate or subsemicircular in outline. Contour unequally biconvex or plano-convex. Shell impunctate. Surface striate or plicate. Ventral valve with the greatest convexity; cardinal area moderately high, slightly inclined outward; delthyrium covered by a convex plate which in the type species *B. coloradoensis* has a minute perforation near the apex; teeth well developed, with dental plates extending to the bottom of the umbonal cavity and forming the sides of a small area opposite the delthyrium, where the pedicle muscle was probably attached. In the dorsal valve the cardinal area is strongly inclined, but less than 90° to the plane of the valve. The delthyrium is partly covered by a convex chilidium, or it may be altogether absent. Cardinal process single. A rudimentary spondylium is indicated for *B. dice*. Shell structure dense, minutely granular, with minute pores scattered through the calcareous lamellæ.

Type.—*Orthis coloradoensis* Shumard.

Observations.—Hall and Clarke [1892c, p. 230] founded the genus on "*Orthis pepina*" Hall, which is a synonym of "*Orthis coloradoensis*" Shumard. The material from the limestones of Texas in the United States National Museum shows the form of the teeth in the ventral valve, also the deltidium and the minute perforation near its apex. Hall and Clarke [1892c, p. 230] state in their diagnosis that "in rare instances (it) may be minutely perforated at the apex," but do not name the species in which the perforation occurs or where the specimens showing it are to be found. All the species known to me are biconvex or plano-convex; none are concavo-convex as defined by Hall and Clarke [1892c, p. 230].

The genus is essentially orthoid, but it differs in the presence of the arched deltidium and its general aspect from typical examples of the Orthidæ, and its shell is of a dense, nonfibrous structure.

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[a] The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Billingsella* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record the following mere generic references are listed:

Orthis Barrande [1848, p. 203].
Orthis Shumard [1860, p. 627].
Orthis Hall [1863, p. 134; 1867, p. 113].
Orthis Davidson [1868, p. 314; 1869, p. 230].
Orthis Linnarsson [1876, pp. 10, 12, and 13].
Orthis Barrande [1879b, Pl. LXII, fig. 11].
Orthis Whitfield [1882, p. 170].
Orthis? (*Orthisina?*) Hall [1883, Pl. XXXVII, figs. 16–19].
Orthis Kayser [1883, p. 35].
Kutorgina Walcott [1884b, p. 18].
Orthisina Whitfield [1884, p. 144].
Orthis? Walcott [1886b, p. 119].
Orthisina Walcott [1886b, p. 120].
Orthis Walcott [1887, p. 190].
Orthis Oehlert [1889, p. 1139].
Orthis? Walcott [1891a, p. 612].
Orthisina Walcott [1891a, p. 613].
Clitambonites (*Gonambonites*) Matthew [1895b, p. 267].
Orthis Wallerius [1895, p. 66].
Orthis Pompeckj [1896b, p. 513].
Orthis (*Billingsella*) Sardeson [1896, p. 96].
Clitambonites Schuchert [1897, p. 184].
Billingsella Walcott [1899, p. 450].
Billingsella Matthew [1903, p. 148].
Orthis (*Plectorthis*) Walcott [1905a, p. 270].
Billingsella Walcott [1908d, pp. 101 and 102].

Of the species referred to the genus, *Billingsella exporrecta* is one that departs from the typical species in the absence of a strong convex deltidium, and *B. dice* has a rudimentary spondylium in the ventral valve, a character not developed in other species of the genus.

For the relations of *Billingsella* to *Nisusia*, see remarks under the latter genus, page 725.

The genus was named in honor of Mr. E. Billings.

Billingsella? appalachia Walcott.

Plate LXXXVII, figures 2, 2a–b.

Billingsella? appalachia Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 231. (Described as below as a new species.)

The outline of the dorsal valve is rounded subquadrate. The height and width of the ventral valve are about the same. Dorsal valve slightly transverse.

The surface is marked by round, very fine, radiating costæ, and lines of growth, with very fine interstitial concentric striæ.

The average ventral valve is about 10 mm. in height, with an equal width. The largest shell observed was a ventral valve with a width of 14 mm.

Cardinal area of the ventral valve rather low. It is divided midway by a rather strong delthyrium.

Observations.—In form and size this shell is much like that of *Wimanella? anomala*. It differs in its strongly marked surface characters. All the specimens are flattened in the shale and nothing is known of the interior characters.

Formation and locality.—**Middle Cambrian**: (121) *Rogersville shale, road just east of Harlan Knob, 4 miles (6.4 km.) northeast of Rogersville [Keith, 1905, areal geology sheet], Hawkins County, Tennessee.*

This species is somewhat doubtfully identified from the following locality:

Middle Cambrian: (14) Limestones overlying the sandstones of the Rome formation, near the wagon road and in a quarry near the railroad track, 7 miles (11.2 km.) southwest of Rome [Hayes, 1902, historical geology sheet], Floyd County, Georgia.

Billingsella bivia n. sp.

Text figures 65A–C.

The specimens of this species are preserved in a sandstone and usually occur in the form of flattened casts. The valves are transverse in outline, equally convex, and have their greatest width at the hinge line. The beak of the ventral valve projects over the hinge line and

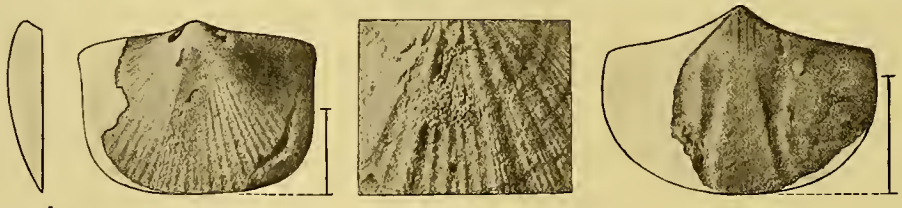

Figure 65.—*Billingsella bivia* n. sp. A, A′, Top and side view of exfoliated dorsal valve, the type specimen, from Locality 141, Lower Cambrian, near Resting Springs, Inyo County, California (U. S. Nat. Mus. Cat. No. 52254a). B, Enlargement (×about 6) of the outer surface, with strong and fine radiating ribs, of a shell from Locality 14p, Lower Cambrian, near Resting Springs, Inyo County, California (U. S. Nat. Mus. Cat. No. 51404). C, Ventral valve from Locality 141, Lower Cambrian, near Resting Springs, Inyo County, California (U. S. Nat. Mus. Cat. No. 52254b).

is flattened so that it barely rises above the plane of the margins of the shell. The hinge line of the dorsal valve is broadly rounded, and most of the specimens show a fairly well marked mesial sinus. A dorsal valve preserving the outer surface shows it to have been covered by coarse, radiating costæ, each of which is marked by a number of minute radiating ridges.

The species is closely related to *Billingsella highlandensis* (Walcott), but differs from that species in being more transverse in outline, in the absence of a concentric striation, and in other details of surface sculpture, and in the prominence of the mesial sinus.

Formation and locality.—**Lower Cambrian**: (141) *Sandstones about 2,800 feet (853 m.) below the Middle Cambrian in a horizon correlated with No. 2j of the Silver Peak group of the Waucoba Springs section [Walcott, 1908f, p.*

187], *in the pass about 7 miles (11.2 km.) east of Resting (Freshwater) Springs;* and (**14p**) sandstones near Resting (Freshwater) Springs; both in the southwest corner of T. 21 N., R. 8 E., on Amargosa River, in the southeastern part of Inyo County, California.

Billingsella coloradoensis (Shumard).

Text figures 6, page 299, 66; Plate LXXXV, figures 1, 1a–z.

Orthis coloradoensis Shumard, 1860, Trans. Acad. Sci. St. Louis, vol. 1, p. 627. (Described as a new species.)

Orthis pepina Hall, 1863, Sixteenth Ann. Rept. New York State Cab. Nat. Hist., pp. 134–135, Pl. VI, figs. 23–27. (Described and discussed as a new species.)

Orthis pepina Hall, 1867, Trans. Albany Inst., vol. 5, p. 113, Pl. I, figs. 23–27. (Copy of preceding reference.)

Orthis pepina Hall, Whitfield, 1882, Geology of Wisconsin, vol. 4, pt. 3, pp. 170–171, Pl. I, figs. 4 and 5. (Described and discussed.)

Orthis? (Orthisina?) pepina Hall, 1883, Second Ann. Rept. State Geologist New York for 1882, Pl. XXXVII, figs. 16–19. (Figs. 16–19 are copied from Hall, 1863, Pl. VI, figs. 23, 25, 24, and 26, respectively.)

Billingsella pepina (Hall), Hall and Clarke, 1892, Eleventh Ann. Rept. State Geologist New York for 1891, Pl. VIII, figs. 1 and 2. (No text reference.)

Billingsella pepina (Hall), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 230, Pl. VII, figs. 16–19; Pl. VIIA, figs. 7–9. (Mentioned in description of genus. Pl. VII, figs. 16–19, are copied from Hall, 1863, Pl. VI, figs. 23, 25, 24, and 26, respectively. Figs. 8 and 9 are copied from figs. 1 and 2, respectively, of the preceding reference.)

Orthis (Billingsella) pepina (Hall), Sardeson, 1896, Bull. Minnesota Acad. Nat. Sci., vol. 4, No. 1, pt. 1, p. 96. (New localities mentioned.)

Billingsella coloradoensis (Shumard), Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 158. (Merely changes generic reference.)

Billingsella coloradoensis (Shumard), Walcott, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, pp. 450–451, Pl. LXI, figs. 1, 1a–d. (Discussed and characterized. Figs. 1, 1a–d are copied in this monograph, Pl. LXXXV, figs. 1a, 1g, 1w, 1o, and 1t, respectively, figs. 1w and 1t being slightly altered.)

Billingsella coloradoensis (Shumard), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 231–234. (Described and discussed essentially as below.)

Billingsella coloradoensis (Shumard), Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 210. (Characterized.)

Shell usually transverse but in many examples the ventral valve is longer than wide. The general outline is irregularly subquadrate to subsemicircular. On the ventral valve the hinge line slopes toward the beak at a low angle while in the dorsal valve it is nearly straight. In some individuals the greatest width is at the hinge line. In others it is at about the middle. There is considerable variation in the relative proportions of length and breadth.

The ventral valve is slightly more convex than the dorsal. The degree of convexity of the two valves varies considerably in specimens from different localities. Some of the ventral valves from beds at Franconia, Minnesota, and the young shells from Trempealeau, Wisconsin, are strongly convex.

Figure 66.—*Billingsella coloradoensis* (Shumard). Posterior view of a ventral valve showing pedicle opening in the deltidium; from Locality **70**, Upper Cambrian, on Morgans Creek, Texas (U. S. Nat. Mus. Cat. No. 34777a).

A low, broad, median sinus occurs on nearly all specimens of the dorsal valve, being straight in the young shells, and occasionally a shallow sinus is clearly defined on the ventral valve. It is quite rare to find a well-marked median fold on the ventral valve.

The surface is marked by sharply rounded, radiating costæ crossed by fine concentric lines of growth and very fine, slightly undulating, concentric striæ. The size and sharpness of the radiating ribs vary greatly in specimens from the same bed at the typical locality in Texas. Shells occur with strong rounded costæ, and no traces of fine elevated lines between, whereas others show from one to four or more lines that start at varying distances from the beak. The imbricating lines of growth give a concentrically ridged aspect to some shells, though others are nearly smooth from beak to frontal margin. The increase in the number of ribs is by interpolation, not by bifurcation.

There is considerable variation in the size of the shell. The largest specimens from Texas have a transverse diameter of 19 mm., with a length of 14 mm. for the dorsal valve, and about 18 mm. for the ventral valve. Specimens of the ventral valve from the Yellowstone National Park have a length of 14 mm. with a width of 15 mm.

Cardinal area of ventral valve moderately high. It is marked by transverse striæ of growth that cross it parallel to its base and arch over the convex deltidium. The plane of the area extends backward at an angle of about 10° to the plane of the margin of the shell. The delthyrium is strong and covered by a convex deltidium, the front margin of which arches back about one-fifth the length of the delthyrium. The deltidium is marked by concentric striæ of growth and fine radiating lines and a minute perforation near its apex. The cardinal area of the dorsal valve is short as compared with the ventral valve. It extends backward at an angle of about 45° to the plane of the margin of the valve. It is divided midway by a strong delthyrium which is covered for about half its distance by a convex chilidium.

In the interior of the ventral valve the hinge teeth appear to be supported by dental plates that extend down to the bottom of the valve and bound the tripartite umbonal space opposite the delthyrium into which the vascular sinuses extend on each side of the diductor muscle impressions, or their path of advance. The traces of the vascular system are confined to the main vascular trunks which extend forward nearly to the front margin, where in some examples they are bifurcated. The inner branch extends in toward the median line, disappearing in the numerous radiating depressions near the margin. The lateral branches appear to connect with the peripheral canal that arches about the space probably occupied by the ovarian areas, between itself and the main vascular trunks. The space for the attachment of the muscles between the main vascular trunks appears to have been quite large, extending forward to the anterior fifth of the length of the valve, but no subdivisions indicating the points of attachment of the different muscles have been detected. The pedicle muscles were probably attached to the elevated, posterior portion of this central area. In some casts this posterior area is scarcely elevated above the plane of the interior. In others it is fairly prominent.

In the interior of the dorsal valve the interior of the deltidial cavity supports a small well-developed cardinal process or callosity, and a slight narrow median ridge occurs just in advance of the deltidial cavity. The crura are short and well defined, with relatively shallow dental sockets beside them. The cardinal process and crura vary in size and length in shells from the same locality. The only traces of the muscle scars observed show the anterior adductor impressions. The vascular trunks of the dorsal valve diverge from the central line about the center of the shell, after passing around the adductor muscle impressions.

Observations.—The average size of the typical specimens from Texas is from 10 to 14 mm. in length for the ventral valve, the width being about the same. At one locality on Morgans Creek several dorsal valves were found that have a width of 18 mm., with a length of 12 mm. This may possibly indicate a variety or distinct species, but with the material in the collection it is impossible to determine definitely. The shells from the upper Mississippi Valley in Wisconsin and Minnesota average about the same size as the typical forms from Texas. The young shells are much more convex. The material from the Gallatin Range, Yellowstone National Park, is also much like that from Texas, but that from the limestone near Malade, Idaho, though it contains typical shells, also has specimens as large as those from Morgans Creek, Texas.

Billingsella major differs from *B. coloradoensis* in the character of the surface striation, also in its larger size. *Billingsella plicatella* is a uniformly smaller and more convex shell, and also has distinct surface characters. The same is true of *B. striata*.

FORMATION AND LOCALITY.—**Lower Ordovician:** (**339** [Sardeson, 1896, pp. 95 and 96]) Oneota dolomite, Stillwater, Washington County, Minnesota..

Upper Cambrian: (**302q**) About 1,000 feet (305 m.) above the quartzitic sandstones in the "Yogo limestone (Devono-Silurian)" of W. H. Emmons [1907, p 34], on Rock Creek, Phillipsburg quadrangle (U. S. Geol. Survey), Granite County; (**302r**) same horizon as Locality 302q, near Princeton, Phillipsburg quadrangle (U. S Geol. Survey), Granite County; (**302f**) limestone in upper part of the Gallatin formation, north side of Elk Pass, between Buffalo and Slough Creeks, Yellowstone National Park, Livingston quadrangle (U. S. Geol. Survey); (**147a**) limestone in Spring Hill Canyon, west side of the Bridger Range, Gallatin County; and (**155**) limestone north of East Gallatin River, near Hillsdale, Threeforks quadrangle (U. S. Geol. Survey), Gallatin County; all in Montana.

(**302p**) Middle limestone of the Deadwood formation near the summit of the Owl Creek Mountains, 18 miles (29 km.) southwest of Thermopolis, Fremont County; (**302g**) limestone on the north slope of Crowfoot Ridge south of the

Gallatin Valley, Gallatin quadrangle (U. S. Geol. Survey), Yellowstone National Park; and (**302h**) limestone on the divide between Panther Creek and West Gallatin (Gallatin) River, Gallatin quadrangle (U. S. Geol. Survey), Yellowstone National Park; all in Wyoming.

(**4y**, **5a**, **5c**, and **54t**) Limestones about 250 feet (76 m.) above the Middle Cambrian; (**54x**) limestone about 200 feet (61 m.) above the Middle Cambrian; and (**54u**) limestone about 100 feet (30.5 m.) above the Middle Cambrian; all in the St. Charles formation [Walcott, 1908a, p. 6], on the north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

(**56g**) Limestones of the St. Charles formation [Walcott, 1908a, p. 6], in the valley of the stream which flows into Mill Canyon from the west, about 6 miles (9.6 km.) west-southwest of Liberty, and 15 miles (24.2 km.) west of Montpelier, Bear Lake County, Idaho.

(**54e**) About 200 feet (61 m.) above the Middle Cambrian and 1,025 feet (312.4 m.) below the top of the Upper Cambrian, in limestones forming 3 of the St. Charles formation [Walcott, 1908f, p. 193]; (**31m** and **55h**) about 175 feet (53.3 m.) above the Middle Cambrian and 1,050 feet (320 m.) below the top of the Upper Cambrian, near the base of the limestones forming 3 of the St. Charles formation [Walcott, 1908f, p. 192]; and (**54f**) 150 feet (45.7 m.) above the Middle Cambrian and 1,075 feet (327.7 m.) below the top of the Upper Cambrian in the light-gray sandstone forming 4 of the St. Charles formation [Walcott, 1908f, p. 193]; all in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

(**14b**) Limestone on Cold Creek at north end of gorge opposite the north end of Sponge Mountain, 2 miles (3.2 km.) south of the San Saba County line, in Llano County; (**14g**) limestone 1 mile (1.6 km.) west of Cherokee, San Saba County; (**68** and **68e**) interbedded sandstone and limestone, Packsaddle Mountain, Llano County; (**69**) limestone near Honey Creek, Burnet County; (**70**, **70a**, and **70e**) limestones near Morgans Creek, Burnet County; (**353a** [*Shumard, 1860, p. 627*]) *sandstones near the head of Morgans Creek, Burnet County;* and (**71**) limestone in Cold Creek Canyon, Burnet County; all in Texas.

(**369e**) Sandstone on Big River, Iron County; (**369d**) upper portion of the Elvins formation, 2.5 to 3 miles (4 to 4.8 km.) north of Caledonia, Washington County; (**111**) arenaceous limestone of the Elvins formation, 50 feet (15.2 m.) above the "Edgewise beds," St. Francois County; and (**11d**) arenaceous limestone about 2 miles (3.2 km.) north of Montana, in sec. 22, T. 35 N., R. 1 E., Iron County; all in Missouri.

"St. Croix sandstone" at the following localities: (**78**) Quarry near St. Croix River in suburbs of Osceola, Polk County; (**79**) bluff near Hudson, St. Croix County; (**79a**) quarry and ledge 0.5 mile (0.8 km.) southeast of the county courthouse, Menomonie, Dunn County; (**100**) near Menomonie, Dunn County; (**80a**) 4 miles (6.4 km.) north of Reedsburg, Sauk County; (**83′**) uppermost horizon near Trempealeau, Trempealeau County; (**97a**) near Winfield, Jefferson County; (**328c**) at Alma, Buffalo County; and (**328d** [Whitfield, 1882, p. 171]) at Berlin, Green Lake County; all in Wisconsin.

(**83**[3]) Green-sand horizon in the "St. Croix sandstone" below the "fifth trilobite bed" of Owen, at Trempealeau, Trempealeau County, Wisconsin.

"St. Croix sandstone" at the following localities: (**84a**) River Junction, Houston County, 20 miles (32.2 km.) below Dresbach; (**97b**) below the green-sand bed and about 25 feet above St. Croix River, at Franconia, Chisago County; (**86a**) near Red Wing, Goodhue County; (**97** and **S97x**) at Reads Landing, foot of Lake Pepin, Wabasha County; (**131**) in a cut on the Chicago, Milwaukee and St. Paul Railway, 4 miles (6.4 km.) southeast of Lake City, Wabasha County; (**339f**) near Minneiska (Miniska), on Mississippi River near the line between Wabasha and Winona counties; (**339h** [Hall, 1863, p. 135]) near the mouth of Minneiska (Miniska) River, near the line between Wabasha and Winona counties; (**98a**) at Marine Mills, on St. Croix River, Washington County; and (**339g**) just below the *Dicellocephalus minnesotensis* beds, near Winona, Winona County; all in Minnesota.

Upper? Cambrian: (**306**) Sandy limestone on Gravel River, on the eastern slope of the Rocky Mountains, in the Mackenzie Basin, British Columbia.

Middle Cambrian: (**5k**) Limestone in Meagher County on the road to Wolsey, about 1 mile (1.6 km.) south of the divide at the head of Sawmill Creek, and 8 miles (12.8 km.) south of Neihart, Little Belt Mountains quadrangle (U. S. Geol. Survey), Cascade County; (**302w**) limestone at Madison Mountain; and (**159**) limestones north of West Gallatin (Gallatin) River, Gallatin County; all in Montana.

(**4e**) Limestones about 950 feet (289.6 m.) above the unconformable base of the Cambrian in the divide at the head of Jackson Creek (locally known as Sheep Creek), a creek flowing into Jackson Lake about 0.5 mile (0.8 km.) south of its northwestern corner, Teton Mountains, Grand Teton quadrangle (U. S. Geol. Survey), Uinta County, Wyoming.

(**5b** and **54s**) Dark blue-gray Langston limestone [Walcott, 1908f, p. 198], just above the Cambrian quartzitic sandstones, north side of Twomile Canyon, near its mouth, 2 miles (3.2 km.) southeast of Malade, Oneida County, Idaho.

(**54o**) About 900 feet (274.3 m.) above the Brigham quartzite and 3,300 feet (1,005.8 m.) below the Upper Cambrian, in the limestone forming 1b of the Ute limestone [Walcott, 1908f, p. 196], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

(**11e**) Thin-bedded limestones south-southwest of Potosi, Washington County, Missouri.

(**2s**) Limestone in upper part of *Paradoxides* zone, Hastings Cove [Matthew, 1898b, p. 38], on Kennebecasis Bay, 0.5 mile (0.8 km.) northeast of Torryburn on the Intercolonial Railway northeast of St. John, St. John County, New Brunswick.

Billingsella dice Walcott.

Plate CI, figures 8, 8a–d.

Billingsella dice Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 234. (Characterized essentially as below as a new species.)

In general form and surface this shell is related to *B. romingeri* (Barrande). It differs from the latter in its strong dental plates, which form a rudimentary spondylium. All the characters known are illustrated.

Formation and locality.—**Lower Ordovician?**: (319f) Drift bowlder of sandstone found near St. Albans, Franklin County, Vermont. The lithologic character of the matrix in which this species was found points to the arenaceous limestones of the Phillipsburg formation just north of the boundary between the United States and Canada as the source of the bowlder.

Billingsella exporrecta (Linnarsson).

Plate LXXXVIII, figures 1, 1a–l.

Orthis exporrecta Linnarsson, 1876, Bihang till K. svensk. Vet.-Akad. Handl., Bd. 3, No. 12, pp. 12–13, Pl. II, figs. 13–19; Pl. III, figs. 20 and 21. (Described and discussed in English as a new species.)

Orthis exporrecta Linnarsson, Kayser, 1883, China, by Richthofen, vol. 4, p. 35. (Discussed in German in the description of "*O. linnarssoni.*")

Orthis exporrecta Linnarsson, Wallerius, 1895, Undersökningar öfver Zonen med *Agnostus lævigatus* i Vestergötland, p. 66. (Localities mentioned in Swedish.)

Billingsella exporrecta (Linnarsson), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 234–236. (Described and discussed essentially as below.)

Shell transversely subsemicircular, with the hinge line usually shorter than the greatest width. In a few examples it is a trifle longer; the cardinal angles are obtusely angular (Pl. LXXXVIII, fig. 1e). The proportions between the length and breadth vary, as shown by the figures. The ventral valve is considerably more convex than the dorsal. The ventral valve is evenly rounded, while the dorsal usually has a flattening of the median area and sometimes a slight, broad sinus. The surface is marked by numerous radiating costæ and very fine concentric striæ between the costæ, and a few visible lines of growth. The costæ are rounded, usually, but not always, broader than the interspaces, and continuous from the umbo to the front and lateral margins; they appear to be quite regular, although varying much in size, and increasing somewhat irregularly by interpolation of new costæ. This usually occurs near the umbo, but may occur near the middle of the valve. The largest ventral valve in the collection has a length of 9 mm. and a breadth of 11 mm. Dorsal valve: Length, 7 mm.; breadth, 10 mm.

Cardinal area of ventral valve high and overhanging the posterior margin. Delthyrium large and triangular in outline; deltidium short, concave, imperforate, and marked by fine, transverse striæ of growth. Cardinal area of dorsal valve short and inclined slightly forward; it is divided midway by a broad delthyrium, which is divided by a strong cardinal process.

In the interior of the ventral valve strong main vascular sinuses extend well forward toward the front margin. The cast of the umbonal cavity opposite the delthyrium shows a tripartite division, the center of which is the area of the path of advance of the diductor muscle impressions, and those on each side appear to be the posterior portion of the main vascular sinuses. The anterior edge of the cavity is marked by a sharp, elevated, forward-arching ridge that extends to the teeth on either side; the dental plates appear to have extended to the bottom of the valve and to have bounded the sides of the triangular umbonal cavity opposite the delthyrium.

The interiors of the dorsal valve are beautifully preserved. The cardinal process, crura, crural plates, area, anterior and posterior adductor muscle scars, and vascular sinuses are very distinct; the dental sockets are shallow, but clearly shown. The great variation in the size, form, and position of the adductor scars is well illustrated by the figures. In figure 1f there appear to be two lateral supporting septa to the thickening before the crural plates that

bound the spaces occupied by the point of attachment of the diductor muscles. Linnarsson describes [1876, p. 12] the cardinal process as triangular. I find it both straight (fig. 1f), subtriangular (fig. 1i), and triangular (figs. 1g and 1h). A short median septum is seen in some shells (fig. 1g), but usually the strong, slightly rounded, flattened median ridge does not carry it.

Observations.—This is one of the most variable species of the genus, both in external, and, as far as known, internal characters. It is very abundant, but interiors of the ventral valve are rarely met with in good condition.

The extremely short, imperforate deltidium of the ventral valve indicates that the pedicle opening had been closed by shell growth, and that this species was nearing the *Eoorthis remnicha* stage of development. It appears to be an intermediate form between *Billingsella* and *Eoorthis*. The concave deltidium is much like that of *Conchidium nysius* Hall and Whitfield [Hall and Clarke, 1894, Pl. LXIV, fig. 7]. It is about one-fifth the length of the delthyrium.

Linnarsson [1876, p. 12] compares *"Orthis exporrecta"* with *"Orthis hicksi,"* which appeared to be most nearly related, pointing out that it differed in having fewer and coarser ribs, less pointed beak, and lower area. The *"Orthis hicksi"* variety is now placed as a variety of *Billingsella exporrecta.*

Formation and locality.—**Upper? Cambrian:** (**310h**) Shale collected somewhere (probably Fogelsång) in the old province of Skåne, Sweden.

Middle Cambrian: Limestones of the *Paradoxides forchhammeri* zone at the following localities: (**320m**)[a] at Kinnekulle, northeast of Lidköping, Province of Skaraborg; (**320n**) *at Lovened, Djupadal, 19 miles (30.6 km.) south-southeast of Skara, Province of Skaraborg*; (**320y**)[a] at Gudhem, 12.5 miles (20.1 km.) south-southeast of Skara, Province of Skaraborg; (**320p**)[a] at Södra Möckleby, southern part of Oeland Island; (**320z**)[a] several places in Nerike; (**320g**) at Borgholm, Oeland Island; (**321q**) at Munkesten, north of Hunneberg; and (**321r**) at Hunneberg, western boundary of the Province of Skaraborg; all in Sweden.

(**3201**)[a] Drift blocks supposed to have come from the *Paradoxides œlandicus* zone [Linnarsson, 1876, p. 6], at Lillviken, near Oestersund, Province of Jemtland; (**321p** [Wallerius, 1895, p. 67]) in strata with *Agnostus lævigatus* at Carlfors, near the north end of Mount Billingen, Province of Wermland; (**310z**) at Brantevik, on the shore a little south of Simrishamn, Province of Christianstad; (**320b**) limestones forming 2d of the *Paradoxides* zone, the *Agnostus lævigatus* horizon, at Gudhem, 12.5 miles (20.1 km.) south-southeast of Skara, Province of Skaraborg; and (**310b**) dark-brown limestone at Borgholm, Oeland Island; all in Sweden.

Billingsella exporrecta rugosicostata Walcott.

Plate LXXXVIII, figures 2, 2a–c.

Orthis hicksi Linnarsson [not Salter MS., Davidson], 1876, Bihang till K. svensk. Vet.-Acad. Handl., Bd. 3, No. 12, pp. 13–14, Pl. III, figs. 22 and 23. (Described and discussed in English.)

Billingsella exporrecta rugosicostata Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 236. (Discussed as below as a new variety.)

Linnarsson [1876, p. 13] recognized that this shell was not the same as his *"Orthis exporrecta"* and placed it provisionally under *Orthis hicksi*, calling attention to the fact that it was nearly related to *O. exporrecta.* With a fine series of specimens for comparison, I place the shell as a variety of *B. exporrecta.* It is characterized by its strong, irregular costæ. Linnarsson [1876, p. 14] gives as the most important differences: "Ventral valve less convex; cast of diductor muscle scars less distinct; dorsal valve more convex and muscle scars more strongly marked; radiating ribs in the casts fewer, stronger, and more angular." All of the differences exist when we compare the extreme forms, but with a good series of specimens most of them pass gradually into forms that are typical of *B. exporrecta.*

Formation and locality.—**Middle Cambrian:** Limestones of the *Paradoxides forchhammeri* zone at the following localities [Linnarsson, 1876, p. 14]: (**320m**) At Kinnekulle, northeast of Lidköping, Province of Skaraborg; (**320n**) at Lovened, Djupadal, 19 miles (30.6 km.) south-southeast of Skara, Province of Skaraborg; and (**320p**) at Södra Möckleby, southern part of Oeland Island; all in Sweden.

(**320b**) *Limestone forming 2d of the Paradoxides zone, the Agnostus lævigatus horizon, at Gudhem, 12.5 miles (20.1 km.) south-southeast of Skara, Province of Skaraborg, Sweden.*

[a] Linnarsson, 1876, p. 13.

Billingsella hicksi (Salter MS.) (Davidson).

Plate XCVII, figures 7, 7a–b.

Orthis hicksii (Salter MS.) Davidson, 1868, Geol. Mag., vol. 5, p. 314, Pl. XVI, figs. 17–19. (Described as a new species; see below for copy.)

Orthis hicksii Davidson, 1869, British Fossil Brachiopoda, vol. 3, pt. 7, No. 3, p. 230, Pl. XXXIII, figs. 13–16. (Described. Figs. 13a and 14a are copied from Davidson, 1868, Pl. XVI, figs. 17a and 18a. Fig. 16a is an enlarged drawing of the specimen figured by Davidson, 1868, Pl. XVI, fig. 19. Figs. 14a, 13a, and 16a are copied in this monograph, Pl. XCVII, figs. 7, 7a–b, respectively.)

Orthis hicksi Davidson, Kayser, 1883, China, by Richthofen, vol. 4, p. 35. (Discussed in German in the description of "*O. linnarssoni.*"

Billingsella hicksi (Davidson), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 237. (Original description, Davidson, 1868, p. 314, copied as below.)

The original description by Davidson follows:

Shell small, transversely oval; hinge line shorter than the greatest breadth of the shell; cardinal angles rounded. Dorsal valve semicircular, moderately convex, slightly longitudinally depressed along the middle. Ventral valve convex, deeper than the opposite one. Area triangular, moderately wide; surface of valves ornamented by about ten principal narrow, radiating ribs, with wide interspaces between each pair, in the middle of which is situated a shorter rib.

Length about 4, width 5, lines.

This shell is most nearly related to *B. exporrecta*. It differs in its more rounded form, fewer radiating ribs, and muscle area of ventral valve.

The specific name was given in honor of Henry Hicks.

Formation and locality.[a]—**Middle Cambrian**: Sandstones in the middle portion of the Menevian at the following localities [Davidson, 1869, p. 230]: (**318d**) at Porth-y-rhaw; (**318h**) at St. Davids; and (**318p**) at Ninewells; all near St. Davids, South Wales.

Billingsella highlandensis (Walcott).

Plate LXXXVII, figures 4, 4a–c.

Orthis? highlandensis Walcott, 1886, Bull. U. S. Geol. Survey No. 30, pp. 119–120, Pl. VIII, figs. 3, 3a–b. (Described and discussed as a new species. The specimens represented by figs. 3, 3a–b are redrawn in this monograph, Pl. LXXXVII, figs. 4c, 4b, and 4, respectively.)

Orthis? highlandensis Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 612, Pl. LXXII, figs. 5, 5a–b. (Mentioned. The figures are copied from those in the preceding reference.)

Billingsella highlandensis Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 237–238. (Described and discussed essentially as below.)

Shell transversely oval or subrotund. Front broadly rounded and nearly straight in the dorsal valve. On the ventral valve the cardinal line slopes toward the beak at an angle of about 20°, while in the dorsal valve it is less than 10°. The greatest width is about the middle of the shell. The ventral valve is moderately convex, being most elevated toward the beak, which is slightly arched over to the cardinal margin.

A dorsal valve associated in the same hand specimen of limestone is more convex than the ventral valve. The cardinal line is shorter than the greatest width of the shell. The median fold is but slightly raised above the general surface, although the front margin has a low, broad arch for the reception of the fold of the ventral valve.

A slight flattening in the central portion of the ventral valve in some specimens forms a low, broad mesial sinus toward the front margin.

The surface is marked by concentric lines of growth and fine radiating ribs; on some specimens stronger ribs occur very much as on *Billingsella coloradoensis* (Pl. LXXXV, figs. 1a–i). Interior casts of the valves show fine, radiating striæ toward the front. In a number of partly exfoliated shells, the shell is shown to be thick and apparently solid, having been replaced by calcite.

The average-sized ventral valve has a length of 13 mm., with a width of 16 mm. One dorsal valve is 17 mm. in width.

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[a] Specimens from localities **318h** and **318p** are included in the collections of the United States National Museum. The type locality is either **318d** or **318p**, Davidson does not indicate which.

Cardinal area of the ventral valve unknown except that its plane extends backward at an angle of about 10° or 15° to the plane of the margin of the shell.

Casts of the interior of the ventral valve show that the dental plates extend down to the bottom of the valve, supporting distinctly defined hinge teeth. The traces of a vascular system are limited to the main vascular trunks, which extend forward well toward the front margin, very much as in *B. coloradoensis*. In one cast (Pl. LXXXVII, fig. 4b) there is a strong furrow extending from a median furrow obliquely outward to each main vascular sinus. The median furrow extends backward to the apex of the cast that filled the space beneath the umbo and the deltidium. This portion of the cast is also marked by fine vertical venation. In another cast there is a very narrow median furrow. These median furrows probably indicate the beginning of a septum that in later forms connected the deltidium with the shell. Nothing is known of the interior of the dorsal valve.

Observations.—Billingsella highlandensis is strongly characterized by its nearly smooth surface, in having the dorsal valve more convex than the ventral, and in the presence in the ventral valve of a sharp ridge beneath the umbo, indicating the beginning of the growth of a median septum.

The specific name is derived from the Highland Range, Nevada.

FORMATION AND LOCALITY.—**Lower Cambrian:** (30) Limestone 8 miles (12.8 km.) north of Bennetts Spring, on the west slope of the Highland Range; and (31a) *limestones and interbedded siliceous shales in the Pioche formation [Walcott, 1908a, p. 11], just above the quartzite on the east side of the anticline, near Pioche;* both in Lincoln County, Nevada.

This species is somewhat doubtfully identified from the following locality:

Lower Cambrian: (178a) Sandstone at the south end of Deep Spring Valley, Inyo County, California.

BILLINGSELLA LINDSTRÖMI (Linnarsson).

Plate LXXXVII, figures 6, 6a–f.

Orthis lindströmi LINNARSSON, 1876, Bihang till K. svensk. Vet.-Akad. Handl., Bd. 3, No. 12, pp. 10–12, Pl. I, figs. 1–8; Pl. II, figs. 9–12. (Described and discussed in English as a new species.)

Billingsella lindstromi WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 238–239. (Characterized and discussed as below.)

The general description of *Billingsella coloradoensis* applies to this species. The casts of the interior have the same general flatness of appearance, and the exterior surfaces are not unlike. In details, the two differ materially. The radiating costæ of *B. lindströmi* are usually stronger; the umbo of the ventral valve is more prominent and the beak more incurved. The interior of the ventral valve shows shorter main vascular sinuses and more limited ovarian areas.

Linnarsson [1876, Pl. I] gives a fine series of illustrations of the interior of the ventral valve, which show that there is considerable variation in the position of the vascular markings. He states that the small cardinal process appears to be bifid. I find it single in a natural cast in the limestone from Alunbruk. There is also a narrow median septum, as in the dorsal valve of *B. coloradoensis*.

Linnarsson [1876, p. 11] writes:

> I do not know any species with which this can be confounded. At least, the adult specimens are always easily recognized. In the young ones the characters are less marked, especially in the dorsal valves. The interior and the internal cast of the ventral valve is in all stages of growth easily recognized.

The specific name was given in honor of Dr. G. Lindström.

FORMATION AND LOCALITY.—**Middle Cambrian:** Limestones of the *Paradoxides forchhammeri* zone at the following localities: (320m)[a] *At Kinnekulle, northeast of Lidköping, Province of Skaraborg;* (320n)[a] at Lovened, Djupadal, 19 miles (30.6 km.) south-southeast of Skara, Province of Skaraborg; (320y)[a] at Gudhem, 12.5 miles (20.1 km.) south-southeast of Skara, Province of Skaraborg; and (320p) at Södra Möckleby, southern part of Oeland Island; all [Linnarsson, 1876, p. 12] in Sweden.

(3201) [Linnarsson, 1876, p. 12]) Drift blocks supposed to have come from the *Paradoxides œlandicus* zone, at Lillviken, near Oestersund, Province of Jemtland; (320q)[a] limestone at Alunbruk (alum works), southern part of Oeland Island; (321t) sandstone at Sularp, near Lund, Province of Malmöhus; and (321u) at Bjorkelunda, south of Simrishamn, Province of Christianstad; all in Sweden.

[a] These localities are represented in the collections of the United States National Museum.

Billingsella major Walcott.

Plate LXXXVI, figures 1, 1a.

Billingsella major Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 239. (Characterized as below as a new species.)
Billingsella major Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 101, Pl. X, figs. 1 and 1a. (Characterized as in the preceding and as below as a new species. Figs. 1 and 1a are copied in this monograph, Pl. LXXXVI, figs. 1 and 1a, respectively.)

In general form and convexity this shell is related to *Billingsella coloradoensis*. It differs from it in being larger and in having coarser radiating ribs. It is the Upper Cambrian representative of the latter species.

Formation and locality.—**Upper Cambrian**: (116) "St. Croix sandstone" in excavation on Well's farm, 2 miles (3.2 km.) west of Baraboo, Baraboo quadrangle (U. S. Geol. Survey), Sauk County, Wisconsin.

Specimens that are somewhat doubtfully referred to this species occur at the following locality:

Upper Cambrian: (369c) Dolomite above the "Edgewise beds," in a railroad cut, 0.5 mile (0.8 km.) southwest of Elvins, 6 miles (9.6 km.) south of Bonneterre, St. Francois County, Missouri.

Billingsella marion Walcott.

Text figures 67A–B.

Billingsella marion Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 102, Pl. X, fig. 5. (Described and discussed as below as a new species. Fig. 5 is copied in this monograph as fig. 67A.)

Dorsal valve transverse; beak small, marginal; sides broadly rounded and merging into the broadly round, almost transverse frontal margin; cardinal line a little shorter than the greatest width of the valve and sloping very slightly from the beak to outer extremities; on one specimen the cardinal angle is extended slightly; greatest width about midway of the length; mesial furrow narrow at the beak and gradually widening to a broad, deep furrow, which divides the valve into two lobes.

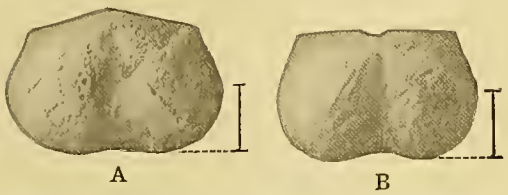

Figure 67.—*Billingsella marion* Walcott. A, Dorsal valve, the type specimen, showing extension of the cardinal angle and a very broad mesial furrow. B, Dorsal valve with obscure radiating ribs.

The specimens represented are from Locality 581, Middle Cambrian on Mount Stephen, British Columbia (U. S. Nat. Mus. Cat. Nos. 53676a and 53676b, respectively). Figure 67A is copied from Walcott [1908d, Pl. X, fig. 5].

Surface smooth, with the exception of a few (six or seven) obscure radiating ribs on each lobe. A specimen 10 mm. in width has a length of 6 mm.

Observations.—This species is represented by three specimens of the dorsal valve. They all indicate a thick shell of the *Billingsella salemensis* (Walcott) type (Pl. LXXXVII, figs. 3 and 3a).

The specific name was given for Mrs. L. D. Burling, who collected the type specimen.

Formation and locality.—**Middle Cambrian**: (581) About 1,830 feet (557.8 m.) above the Lower Cambrian in limestones forming 3b of the Stephen formation [Walcott, 1908c, p. 238 (7)], on the east side of Mount Stephen, about 3,000 feet (914.4 m.) above the Canadian Pacific Railway track, 3.5 miles (5.6 km.) east of Field, British Columbia, Canada.

Billingsella obscura Walcott.

Plate LXXXVI, figure 6.

Billingsella obscura Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 239. (Characterized as below as a new species.)

This species is founded on a single dorsal valve that occurs in the form of a cast in sandstone. It is transverse, width 18 mm., length 13 mm.; moderately convex, with a slightly defined mesial flattening that broadens out nearly to three-fifths the width of the shell at the front margin. The surface of the cast is marked by a few faintly defined, rather broad costæ.

The shell is much like the large dorsal valves of *Billingsella coloradoensis*. It differs in its broader frontal margin and median flattening.

Formation and locality.—**Middle Cambrian**: (74) Sandstone about 300 feet (91.4 m.) above the base of the Tonto group at the head of Nunkoweap Valley, Grand Canyon of the Colorado, Arizona.

Billingsella orientalis (Whitfield).

Plate LXXXVI, figures 2, 2a–b.

Orthisina orientalis Whitfield, 1884, Bull. Am. Mus. Nat. Hist., vol. 1, p. 144, Pl. XIV, fig. 6. (Described and discussed as a new species. Fig. 6 is copied in this monograph, Pl. LXXXVI, fig. 2.)

Orthisina orientalis Whitfield, Walcott, 1886, Bull. U. S. Geol. Survey No. 30, p. 120, Pl. VII, fig. 6. (Original description, Whitfield, 1884, p. 144, copied and species discussed. Fig. 6 is copied from fig. 6 of the preceding reference.)

Orthisina orientalis Whitfield, Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 613, Pl. LXXII, fig. 8. (Mentioned. Fig. 8 is copied from Whitfield, 1884, Pl. XIV, fig. 6.)

Billingsella orientalis (Whitfield), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 230. (Merely changes generic reference.)

Billingsella orientalis (Whitfield), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 239–240. (Described and discussed as below.)

The original description by Whitfield follows:

Shell quadrangular in outline, somewhat higher than wide, with vertical and subparallel lateral margins, and broadly rounded base. Cardinal line rapidly sloping from the apex to the extremities, which are slightly rounded. Hinge line straight, as long as the greatest width of the shell. Cardinal area broad and high, divided in the middle by a triangular foramen, which is about as high as wide. Surface of the ventral valve moderately convex, marked by very fine radiating striæ and also by several concentric lines of growth. Filling of the rostral cavity and foramen large and prominent. Specimen, a cast in shale, of the ventral valve only.

Observations.—The type specimen as described above is flattened in the shale, and also appears to be compressed laterally. Uncompressed specimens referred to this species, from the siliceous limestones east of Swanton show the ventral valve to have been rather strongly convex, and the dorsal valve moderately so. The outer surface as shown in the cast indicates that it was somewhat like that of *Billingsella coloradoensis*, but that it differs in having finer and more numerous threadlike costæ. A few traces of concentric striæ and lines of growth are preserved. The material is very unsatisfactory, but it is sufficient to indicate that the genus occurs in association with *Olenellus thompsoni* in the upper beds of the Lower Cambrian section.

Formation and locality.—**Lower Cambrian:** (**25a**) Limestone on the Hall (Donaldson's) farm, 2 miles (3.2 km.) east of Swanton; (**26**) sandstone northeast of the Corman farm buildings, east of Highgate Springs; (**319m**) shales of No. 6 of the section at Parker's quarry [Walcott, 1891b, p. 278], near Georgia; and (**319g** [*Whitfield, 1884, p. 144*]) *shales at Parker's quarry, near Georgia;* all in Franklin County, Vermont.

Billingsella plicatella Walcott.

Text figure 1, page 299; Plate LXXXVI, figures 3, 3a–n.

Billingsella plicatella Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 240–241. (Described and discussed as below as a new species.)

Shell irregularly subquadrate in outline. In the ventral valve the cardinal line slopes toward the beak at an angle of from 5° to 10°, whereas in the dorsal valve it is usually about 1° to 3°. The greatest width of the shell is about the middle. There is some variation in the relative proportions of length and breadth. Usually, however, the ventral valve is fully as long as wide, while in the dorsal valve it is slightly transverse. The ventral valve is rather strongly convex, the dorsal valve being less so. A low, broad mesial sinus occurs on nearly all specimens of the dorsal valve, and sometimes a distinct sinus on the ventral valve.

The surface is marked by costæ that give it a plicated appearance in many specimens; also, concentric lines of growth and very fine, slightly undulating striæ. On some shells the costæ and surface markings have been almost entirely removed by abrasion while in others they are clear and distinct. There is a considerable range of variation in the strength and form of the surface markings. These are illustrated by the figures on Plate LXXXVI.

When the shell is exfoliated, fine radiating lines occur toward the front margins. The average size of the shell gives a width of about 8 mm., and in the ventral valve a nearly equal length. One specimen has a width of 11 mm.

Cardinal area well defined. It is marked by transverse striæ of growth parallel to the base. The plane of the area extends backward over the cardinal line at an angle of 10° to the plane of the margin of the shell. The delthyrium is well defined and covered by a convex deltidium, the extent of which, however, is unknown. The cardinal area of the dorsal valve is short. No details of the structure have been observed.

The cast of the interior of the ventral valve indicates short hinge teeth supported by dental plates. The markings left on the shell by the vascular system, as shown in casts, are two main vascular trunks which extend nearly in a straight line from the side of the cast of the deltidial cavity obliquely outward to the anterior fourth of the valve, where they bifurcate. The inner branch extends in toward the median line, while the lateral branches extend outward, appearing to unite with the peripheral canal. The latter arches about the space that was probably occupied by the ovarian areas, between itself and the main vascular trunks. The spaces for the attachment of the muscles between the main vascular trunks appear to have been large. No subdivision indicating the points of attachment of the different muscles has been detected. At the posterior portion of the central area there was a narrow, elevated space that posteriorly passes into the deltidial cavity. The pedicle muscles were probably attached to the front part of this elevated space. Short, radiating striæ near the margin indicate the presence of minute vascular canals.

In the interior of the dorsal valve the interior of the deltidial cavity supports a small, well-developed cardinal process or callosity. The crura are short and small, with rounded dental sockets beside them. Nothing is definitely shown of the vascular trunks or mesial impressions in the dorsal valve.

Observations.—In form this species is not unlike the convex forms that have been referred to *Billingsella coloradoensis* (Shumard) from Trempealeau, Wisconsin. It differs from the latter in having strongly marked surface plications and a narrower deltidium. From *B. striata* it differs in surface characters; also in having a more convex dorsal valve.

Formation and locality.—**Upper Cambrian:** (**150a**, **153**, and **154**) Limestones on Dry Creek, just above the mouth of Pass Creek, about 5 miles (8 km.) north of Hillsdale; (**151a**) limestone in point overlooking Churn Canyon on the west side of the Bridger Range; (**157** and **158**)[a] *limestone north of East Gallatin River, near Hillsdale;* and (**156b**) limestone north of East Gallatin River, at the north end of the Gallatin Valley; all in the Threeforks quadrangle (U. S. Geol. Survey), Gallatin County, Montana.

(**152**) Limestone on ridge between Churn and Cottonwood canyons; and (**151**) limestone in point overlooking Churn Canyon; both on the west side of the Bridger Range, Gallatin County, Montana.

Middle Cambrian: (**9h**) Limestone on Beaver Creek, 5 miles (8 km.) north of York, about 8 miles (12.8 km.) north of Canon Ferry, Big Belt Mountains, Fort Logan quadrangle (U. S. Geol. Survey), Meagher County, Montana.

(**4j**) Limestone at the head of Deep Creek, Canyon quadrangle (U. S. Geol. Survey), Yellowstone National Park, Wyoming.

Billingsella pumpellyi Walcott.

Plate XCVII, figures 8, 8a–c.

Billingsella pumpellyi Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 242. (Described and discussed as below as a new species.)

General outline subsemicircular, greatest width at the hinge line or a little in advance of it; considerable variation exists in the relative proportions of length and width; a ventral valve 8 mm. long has a width of 9 mm.; the dorsal valve is more transverse, length 5.5 mm., width 8 mm. The ventral valve is strongly convex, with the umbo arching over to the apex, which is a little above the plane of the margins of the valve; a very slight median fold occurs near the front margin; dorsal valve slightly convex and with a shallow median sinus.

The surface is marked by low, sharp ribs with wide interspaces on which fine radiating striæ occur. Concentric lines and striæ of growth cross the radiating striæ and ribs.

The characters of the cardinal areas of the valves are almost unknown; that of the ventral valve appears to have been of moderate height and inclined but a little from the plane of the valve; one interior of the dorsal valve shows a low cardinal process. The cast of the interior

[a] **158** is the type locality.

of the ventral valve shows the presence of a tripartite, elevated umbonal space into which the strong main vascular sinuses extend, as in *Billingsella coloradoensis* (Shumard); the sinuses extend forward nearly to the front margin of the valve. Of the interior of the dorsal valve only the presence of a strong median ridge is known.

Observations.—This species is one of the costate species of the type of *Billingsella coloradoensis* (Shumard) and *B. romingeri* (Barrande). It differs from them in surface characters. It may be considered the trans-Pacific representative of *B. coloradoensis*.

The specific name was given in honor of Raphael Pumpelly.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**C36**) Upper part of the Chaumitien limestone [Blackwelder, 1907a, p. 36 (part of 3d list of fossils), and fig. 9 (bed 2), p. 35], at Chaumitien, Changhia district; and (**C61**) *a dense black limestone in the uppermost limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 41 (3d list of fossils) and fig. 10 (bed 13), p. 38], 3 miles (4.8 km.) southwest of Yenchuang;* both in Shantung, China.

BILLINGSELLA RETROFLEXA (Matthew).

Plate XC, figures 1, 1a–h.

Not *Gonambonites plana retroflexa* DE VERNEUIL [PANDER, 1830, Beiträge zur Geognosie des russischen Reiches, p. 77, Pl. XXV, figs. 1 and 2].

Clitambonites (Gonambonites) plana retroflexa MATTHEW, 1895, Trans. Roy. Soc. Canada for 1895, 2d ser., vol. 1, sec. 4, No. 13, p. 267, Pl. II, figs. 1a–c. (Original description of *Gonambonites plana retroflexa* by de Verneuil [Pander, 1830, p. 77] copied and variety from Cape Breton described and discussed. The specimens represented by figures 1a and 1b are redrawn in this monograph, Pl. XC, figs. 1g and 1f, respectively.)

Clitambonites planus retroflexus (Matthew), SCHUCHERT, 1897, Bull. U. S. Geol. Survey No. 87, p. 184. (Merely changes generic reference.)

Billingsella retroflexa MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 148–151, Pl. X, figs. 2a–e. (Described and discussed. Figs. 2a, 2c, and 2e are copied from Matthew, 1895b, Pl. II, figs. 1a–c, respectively. The specimens represented by figs. 2a, 2c, and 2d are redrawn in this monograph, Pl. LX, figs. 1g, 1f, and 1c, respectively.)

Orthis (Plectorthis) retroflexa (Matthew), WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 270–271. (Characterized and discussed essentially as below.)

This species is distinguished by the fine radiating costæ on the ventral valve (Pl. XC, figs. 1, 1a–c) and coarser costæ on the dorsal (fig. 1f). The fine longitudinal striæ on the costæ are shown by figure 1e. The latter are similar to those of *Eoorthis remnicha* (Pl. XCII fig. 2c). All that could be definitely determined of the interior of the valves in the type material sent me by Matthew is shown by figures 1f, 1g, and 1h. In figure 1g of the ventral valve the casts of the pseudospondylium, area, and base of the main vascular sinuses are shown. In figure 1f of the dorsal valve the casts of the strong cardinal process, dental sockets, and crura are shown, and in figure 1h the ovarian areas and the visceral area between them. Matthew [1903, p. 148] describes other features of the interior of the valves.

The character of the costæ and general features of this shell, as far as known, appear to class it with *Billingsella romingeri* (Barrande) (Pl. XC) and *B. coloradoensis* (Shumard) (Pl. LXXXV).

Matthew's very full description [Matthew, 1903, pp. 148–151] should be read by the student of this species. By inadvertence [Walcott, 1905a, p. 270] I referred it to *Orthis (Plectorthis)*, a name which I was then using to include those forms which are now placed under *Eoorthis*.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**307d** [Matthew, 1903, p. 149]) Sandy limestone of Matthew's [1903, p. 19] Etcheminian, on Young (McFees) Point, near George River, Cape Breton, Nova Scotia.

BILLINGSELLA RICHTHOFENI Walcott.

Plate LXXXIX, figure 1.

Billingsella richthofeni WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 242–243. (Characterized and discussed as below as a new species.)

This species is represented by two specimens of the exterior of the ventral valve measuring 4 and 5 mm., respectively, in length and width, these being about the same. The outer surface is marked by fine, obscure, radiating ribs and very fine concentric striæ. The general

form is much like that of the ventral valve of *Billingsella pumpellyi*. It differs from the latter in having a shorter hinge line in proportion to the width, in the more uniform and stronger convexity of the surface, and in the more elevated apex.

The species is named after Dr. Ferdinand von Richthofen.

FORMATION AND LOCALITY.—**Lower Cambrian: (C3)** Lower part of the Manto shale [Blackwelder, 1907a, p. 28 (list of fossils at bottom of page), and fig. 8a (bed 20), p. 28] 2.5 miles (4 km.) southwest of Yenchuang, Sintai district, Shantung, China.

A single specimen of a fragmentary ventral valve that may belong to this species occurs in the following locality:

Lower Cambrian: (C20) Central part of the Manto shale [Blackwelder, 1907a, p. 26 (last list of fossils), and fig. 6 (bed 14), p. 25] on the west side of an isolated butte 1 mile (1.6 km.) south of Changhia, Shantung, China.

BILLINGSELLA ROMINGERI (Barrande).

Plate XC, figures 2, 2a-n.

Orthis romingeri BARRANDE, 1848, Naturw. Abhandl., von Haidinger, Bd. 2, Abth. 1, No. 5, p. 203, Pl. XVIII, figs. 5a-d. (Described and discussed in German as a new species.)

Orthis romingeri BARRANDE, 1879, Système silurien du centre de la Bohême, vol. 5, pt. 1, Pl. LXII, figs. II: 1–4. (Figs. 3a, 3c, 3b, 3d, and 3e are copied in this monograph, Pl. XC, figs. 2, 2a-d, respectively.)

Orthis romingeri Barrande, POMPECKJ, 1896, Jahrb. K.-k. geol. Reichsanstalt, Bd. 45, Hft. 3, pp. 513–514, Pl. XV, figs. 1–5a. (Described and discussed in German.)

Billingsella romingeri (Barrande), WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 243–244. (Described and discussed as below.)

Shell transverse, the general outline being irregularly subquadrate to subsemicircular. On the ventral valve the cardinal line slopes toward the beak at a low angle, while in the dorsal valve it is approximately straight. In some shells the greatest width is at the hinge line, while in others it is about the middle of the valve. There is considerable variation in length and breadth, as may be seen by comparing the figures illustrating this species.

The ventral valve is rather strongly convex and the dorsal valve moderately so. The dorsal valve is slightly flattened from the umbo to the frontal margin, the flattening sometimes taking the form of a shallow depression. A low, broad mesial sinus occurs on the dorsal valve and is strongly marked in the young shells. The surface is marked by rounded, bifurcating, radiating costæ crossed by concentric lines of growth and undulating concentric striæ. The radiating costæ vary in size and character in specimens from the same locality. In some specimens they are very regular, while in others there will be wider interspaces or a variation in the manner of interpolation. The ridges of growth also vary in strength and elevation in different shells.

The largest shell in a considerable quantity of material has a length in the ventral valve of 13 mm. and in the dorsal valve of 10 mm., with a width of 15 mm. Cardinal area of ventral valve rather high and slightly incurved. It is marked by transverse striæ of growth that cross it parallel to its base; the plane of the area extends backward at an angle of about 10° to the plane of the margin of the shell; the delthyrium is rather large; a deltidium is indicated in some of the casts, but none of the specimens show it clearly. The cardinal area of the dorsal valve is about one-half the length of that of the ventral valve; it extends backward at an angle of more than 45° to the plane of the margin of the valve and is divided midway by a strong delthyrium which is covered, for a part of its distance at least, by a convex chilidium.

The traces of the vascular system in the ventral valves are seen in the main vascular trunks, which extend well forward toward the front margin, where they appear to bifurcate, the inner branch extending toward the median line and the lateral branches apparently connecting with the peripheral canal that arches backward about the ovarian areas between it and the main vascular trunks. No points of attachment of the various muscles in the ventral valve have been observed. The area in which the diductor muscles are attached is well marked in Plate XC, figures 2h and 2i, and the cardinal process of the dorsal valve in figures 2j and 2k. There

are also in the dorsal valve the anterior adductor impressions, as shown in figure 2k. In the interior of the dorsal valve the deltidial cavity separates a small cardinal process or callosity, which is straight (fig. 2l) or subtriangular (fig. 2k). The crura are relatively long and very prominent, with distinctly defined dental sockets beside them.

Observations.—This species was well illustrated by Barrande [1879a, Pl. LXII, fig. 11], and I have copied five of his figures of a specimen showing the two valves united. In the material of the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts, there is a fine series, illustrating the interior of the ventral and dorsal valves, that, through the kindness of Dr. Alexander Agassiz, I was enabled to study and illustrate.

The species in its external and internal shape varies so decidedly from all described forms that it is not necessary to point out differences between them.

The specific name was given in honor of Dr. Carl Rominger.

Formation and locality.—**Middle Cambrian:** (**345** [Pompeckj, 1896b, p. 509])[a] Greenish shale in the *Paradoxides* zone, on the Dlouhá Hora, above the brook of Sbirov, near Skrej; (**345c**)[a] in shales of Étage C at Mleschitz; (**345f**) *in Étage C [Barrande, 1879a, Pl. LXII], near Skrej;* (**345g**) in Étage C [Barrande, 1879a, Pl. LXII], at Praschno Augezd; (**345l**)[a] shales of Étage C at Jinec; and (**345h**) in Étage C [Barrande, 1879a, Pl. LXII], at Slap; all in Bohemia, Austria-Hungary.

Billingsella salemensis (Walcott).

Plate LXXXVII, figures 3, 3a.

Orthis salemensis Walcott, 1887, Am. Jour. Sci., 3d ser., vol. 34, pp. 190–191, Pl. I, figs. 17 and 17a. (Described and discussed as below as a new species. The specimens represented by figs. 17 and 17a are redrawn in this monograph, Pl. LXXXVII, figs. 3 and 3a, respectively.)

Orthis salemensis Walcott, Oehlert, 1889, Annuaire géologique universel for 1888, tome 5, 1889, p. 1139. (Described in French.)

Orthis salemensis Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, pp. 612–613, Pl. LXXII, figs. 6 and 6a. (The text and figures are copied from Walcott, 1887, pp. 190–191, Pl. I, figs. 17 and 17a, respectively.)

Billingsella salemensis Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 245. (Text copied from Walcott, 1887, pp. 190–191.)

Shell about the average size of the Cambrian species of the genus. Transversely subquadrilateral; front broadly rounded and slightly sinuate midway; hinge line as long as the greatest width of the shell.

Ventral valve convex, most elevated about one-fourth the distance from the beak to the anterior margin; beak small and incurved to the margin of the medium-sized area; the surface of the area and the foramen have not been observed; mesial sinus broad and shallow, it is marked by a low median rib and laterally by two costæ on each side, a third appearing just outside the sinus.

The dorsal valve, associated in the same hand specimen of limestone, is slightly more convex; frontal margin with a rather deep sinuosity to receive the projection of the ventral valve; median fold broad and but slightly elevated, marked by two or three low costæ; the beak appears in the broken specimen in the collection to be scarcely elevated above the surface of the shell, and to terminate at the cardinal margin; area unknown.

The surface of both valves is marked by fine concentric lines of growth, and low, rounded costæ, varying in number from six or seven, as in the specimens figured, to twelve to fourteen in other specimens.

In the broad costæ and the general aspect of the shell this species is unlike any known to me from the Cambrian, with the exception of *Billingsella whitfieldi* (Walcott), from which, however, it differs in strength and character of costæ and outline of valves.

The specific name is derived from Salem, New York.

Formation and locality.—**Lower Cambrian:** (**319b**) Conglomeratic limestones at St. Simon; and (**319h**) limestone bowlders in conglomerate at Metis on the St. Lawrence below Quebec; both in the Province of Quebec, Canada.

[a] These localities are represented in the collections of the United States National Museum.

(2b) Limestone just north of Beman Park, in the northeastern part of the city of Troy, Troy quadrangle (U. S. Geol. Survey), Rensselaer County; (22a) limestone in Penrhyn quarries, Middle Granville, Mettawee quadrangle (U. S. Geol. Survey), Washington County; and (367a) limestone about 0.33 mile (0.5 km.) south of John Hulett's farmhouse, 3 miles (4.8 km.) west of South Granville and 4.5 miles (7.2 km.) southwest of Granville, Fort Ann quadrangle (U. S. Geol. Survey); all in New York.

(338d) Limestone 1 mile (1.6 km.) south of Shushan; (21 and 37) shales and limestone 1.5 miles (2.4 km.) south of Salem; (36) *limestone 1 mile (1.6 km.) south of Shushan and 3.5 miles (5.6 km.) north-northeast of Cambridge;* and (33) limestone on the roadside near Rock Hill schoolhouse, near North Greenwich, about 5 miles (8 km.) northwest of Greenwich; all in the Cambridge quadrangle (U. S. Geol. Survey), Washington County, New York.

Specimens that are doubtfully referred to this species occur at the following locality, the stratigraphic horizon of which is doubtful:

Lower Cambrian: (367b) Sandstone at Lansingburg, north of Troy, Cohoes quadrangle (U. S. Geol. Survey), Rensselaer County, New York.

Billingsella striata Walcott.

Plate LXXXVI, figures 4, 4a–c.

Billingsella striata Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 245. (Characterized as below as a new species.)

The form of the ventral valve of this species is much like that of *Billingsella plicatella*. It differs in having a finely striated outer surface, and in the strong development of the main vascular sinuses, and the broader deltidial cavity. The only two specimens of the dorsal valve are nearly flat.

Formation and locality.—**Middle Cambrian:** (149a) Limestone at the forks of Pole Creek, above Cherry Creek basin, Threeforks quadrangle (U. S. Geol. Survey), Madison County, Montana.

Billingsella whitfieldi (Walcott).

Plate LXXXVI, figures 5, 5a.

Kutorgina whitfieldi Walcott, 1884, Mon. U. S. Geol. Survey, vol. 8, pp. 18–19, Pl. IX, figs. 4, 4a–b. (Described and discussed essentially as below as a new species. The specimens represented by figs. 4, 4a–b are redrawn in this monograph, Pl. LXXXVI, figs. 5 and 5a, respectively.)

Billingsella whitfieldi (Walcott), Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 159. (Merely changes generic reference.)

Billingsella whitfieldi Walcott, 1905, Proc. U. S. Nat Mus., vol. 28, p. 246. (Described and discussed as below, an almost exact copy of the original description, Walcott 1884b, pp. 18–19.)

Shell convex, hinge line straight and a little less than the greatest width of the shell, sides rounding regularly into the slightly convex frontal margin.

Ventral valve fairly convex, elevated along the center to form a flat depressed fold, and sloping somewhat rapidly from this to the lateral and cardinal margins; median elevation with about five rather faintly defined, simple plications, that reach up to the higher portion of the valve; beak small, a little depressed, and rising above the area; cardinal margins straight and diverging from the beak at an obtuse angle; character of area unknown.

Dorsal valve depressed convex, with a rather wide, shallow median depression, and two short plications on each side of it toward the front, which are obsolete in some of the specimens; the area between the cardinal edges and the elevation of the sides of the mesial depression is depressed and corresponds to the flattened lateral slope of the ventral valve.

Surface marked by fine, very clearly defined concentric striæ that are crowded together into narrow ridges, and are subparallel to the front and lateral margins of the shell.

Billingsella whitfieldi belongs with the group of species including *B. salemensis*, or shells with coarse plications and very fine concentric striæ. The latter species occurs with the *Olenellus* fauna in eastern New York, and *B. whitfieldi* in the Middle Cambrian of central Nevada.

The specific name was given in honor of R. P. Whitfield.

Formation and locality.—**Middle Cambrian:** (55b) *Top of the Eldorado limestone [see Walcott, 1908f, p. 184], west side of Secret Canyon;* and (55) shaly limestone at the top of the Eldorado limestone [Walcott, 1908f, p. 184], east slope of Prospect Mountain, in New York Canyon; both in the Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

Genus ORUSIA Walcott.[a]

Orthis (*Orusia*) Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 273. (Characterized and discussed essentially as below as a new subgenus.)

Orusia Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 148. (Classification of genus.)

Orthis lenticularis of authors is not an *Orthis* as restricted by Hall and Clarke [1892c, pp. 192–194]. It appears to belong more nearly to the group of species assembled under *Eoorthis*. It departs from *Eoorthis* in its very thin shell, subequally convex valves, small umbonal cavity, and wide variation in form and surface characters.

Type.—*Anomites lenticularis* Wahlenberg [1821, p. 66].

Orusia? eurekensis (Walcott).

Plate CI, figures 7, 7a.

Orthis eurekensis Walcott, 1884, Mon. U. S. Geol. Survey, vol. 8, pp. 22–23, Pl. IX, figs. 8 and 8a. (Described as a new species. The specimens represented by figs. 8 and 8a are redrawn in this monograph, Pl. CI, figs. 7a and 7, respectively.)

Protorthis? eurekensis (Walcott), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 232. (Merely changes generic reference.)

Orthis? eurekensis Walcott, Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 286. (Merely accepts the original generic reference.)

Orthis (*Orusia?*) *eurekensis* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 277. (Described and discussed as below.

General form rounded subquadrate; strongly convex. Surface marked by fine, rounded, radiating ribs, five in the distance of 1 mm. Length of ventral valve, 4 mm.; width, 4.5 mm.; dorsal valve a trifle shorter.

Ventral valve with a high median fold over the umbo, that widens and flattens toward the front margin, which is arched to receive the projecting median depression of the dorsal valve. The umbo curves over to the apex, which overhangs the hinge line. Area low and strongly inclined backward. The interior cast shows that there was a thick pseudospondylium, but no details of it are preserved.

Dorsal valve with a deep, gently curved median sinus or depression that extends from the umbo to the front margin. In the cast strong anterior adductor muscle scars are shown on the sides of the median depression, and just back of them, in the sinus, what may be the smaller posterior adductor scars.

Observations.—This strongly marked shell suggests some of the more convex shells of *Orusia lenticularis* (Wahlenberg); it differs in its fine ribs, deep median sinus in the dorsal valve, and the sharp fold of the ventral valve; also in the presence of a thickened shelf beneath the umbo of the ventral valve that suggests a spondylium; this character, however, is sometimes indicated in *O. lenticularis* (Pl. XCVIII, figs. 1c and 1e).

The specific name is derived from Eureka district, Nevada.

Formation and locality.—**Middle Cambrian**: (55b) Top of the Eldorado limestone [Walcott, 1908f, p. 184] west side of Secret Canyon, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

Orusia lenticularis (Wahlenberg).

Plate XCVIII, figures 1, 1a–p, 2, 2a–k, 3, 3a–b, 6, 6a–c.

Anomites lenticularis Wahlenberg, 1821, Nova Acta Regiæ Soc. Sci. Upsaliensis, vol. 8, Petrificata telluris Svecanæ, pp. 66–67. (Described in Latin as a new species; see Matthew, 1892, p. 46, for copy of original, and translation.)

Atrypa? lenticularis (Wahlenberg), Dalman, 1828, K. Svensk. Vet.-Acad. Handl. for 1827, pp. 132–133. (Described in Latin; see Matthew, 1892, p. 46, for copy of original, and translation.)

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[a] Prior to the definition of the genus *Orusia* the species now placed under that genus were referred to the following genera:

Anomites Wahlenberg [1821, p. 66].
Atrypa? Dalman [1828, p. 132].
Spirifera? von Buch [1834, p. 48].
Atrypa? Hisinger [1837, p. 76].
Atrypa Kjerulf [1857, p. 92; 1865, p. 3].
Orthis Salter [1866, p. 339].
Orthis Davidson [1868, p. 314; 1869, p. 230].
Orthis Kayser [1876, p. 9].
Orthis Roemer [1876, Pl. II, figs. 4a–c].
Atrypa Kjerulf [1879, Pl. XIII].
Orthis Salter and Etheridge [1881, p. 544].
Orthis Brögger [1882, p. 48].
Orthis Walcott [1884b, p. 22].
Orthis Roemer [1885, p. 33].
Orthis Matthew [1892, pp. 46, 48, and 49].
Protorthis? Hall and Clarke [1892c, p. 232].
Orthis? Schuchert [1897, p. 286].
Orthis Matthew [1903, pp. 213, 216, and 217].

Spirifera? lenticularis (Wahlenberg), VON BUCH, 1834, Physikal. Abhandl. K. Akad. Wiss. Berlin, p. 48, Pl. I, figs. 13 and 14. (Described in German; see Matthew, 1892, p. 47, for translation.)

Atrypa? lenticularis (Wahlenberg) HISINGER, 1837, Lethæa Svecica, p. 76. (Not seen.)

Atrypa lenticularis (Wahlenberg), KJERULF, 1857, Geologie des südlichen Norwegens, p. 92. (Locality mentioned in German.)

Atrypa lenticularis (Wahlenberg), KJERULF, 1865, Veiviser ved Geologiske Excursioner i Christiania Omegn, p. 1, and figs. 7a–d, p. 3. (Mentioned and locality given in Norwegian.)

Orthis lenticularis (Wahlenberg), SALTER, 1866, Mem. Geol. Survey Great Britain, vol. 3, p. 339, Pl. IV, figs. 8–10. (Described and discussed; see Matthew, 1892, p. 47, for copy.)

Orthis lenticularis (Wahlenberg), DAVIDSON, 1868, Geol. Mag., vol. 5, p. 314, Pl. XVI, figs. 20–22. (Occurrence mentioned and new localities given.)

Orthis lenticularis (Wahlenberg), DAVIDSON, 1869, British Fossil Brachiopoda, vol. 3, pt. 7, No. 3, pp. 230–232, Pl. XXXIII, figs. 22–28. (Described and discussed, copying Wahlenberg's original description in Latin, 1821, p. 66. Figs. 22, 23 and 24, and 25 are copied from Salter, 1866, Pl. IV, figs. 9a, 9b, and 9c, respectively; figs. 28 and 28a are copied from Davidson, 1868, Pl. XVI, figs. 22 and 22a; and figs. 26, 26a–b are redrawn from the specimen figured by Davidson, 1868, Pl. XVI, figs. 21 and 21a.)

Orthis lenticularis (Wahlenberg)?, KAYSER, 1876, Beiträge zur Geologie und Palæontologie der argentinischen Republik, vol. 2, Paleontologischen Theil, Abth. 1, p. 9, Pl. I, figs. 11 and 12. (Characterized and discussed in German; see pp. 767–768 for translation.)

Orthis sp., KAYSER, 1876, idem, p. 9, Pl. I, fig. 13. (Characterized in German; see p. 768 for translation.)

Orthis lenticularis (Wahlenberg), ROEMER, 1876, Lethæa geognostica, pt. 1, Lethæa palæozoica, Atlas, Pl. II, figs. 4a–c. (No text reference. Fig. 4a is copied from Salter, 1866, Pl. IV, fig. 9a; figs. 4b and 4c are copied from Davidson, 1869, Pl. XXXIII, figs. 26b and 26a, respectively.)

Atrypa lenticularis (Wahlenberg), KJERULF, 1879, Sydlige Norges Geologi, atlas, Pl. XIII. (Gives position in vertical section.)

Orthis lenticularis (Wahlenberg), SALTER and ETHERIDGE, 1881, Mem. Geol. Survey Great Britain, vol. 3, 2d ed., pp. 544–545, Pl. IV, figs. 8–10. (Text and figures copied from Salter, 1866, p. 339, Pl. IV, figs. 8–10.)

Orthis lenticularis (Wahlenberg), BRÖGGER, 1882, Die silurischen Etagen 2 und 3, p. 48. (Specimens from new localities discussed in German.)

Orthis lenticularis (Wahlenberg), ROEMER, 1885, Paleontologische Abhandlungen von Dames und Kayser, Bd. 2, Hft. 5, pp. 33–34 (280–281), Pl. I (XXIV), figs. 9a–c. (Occurrences of the species discussed in German. Fig. 9a is copied from Salter, 1866, Pl. IV, fig. 9a; figs. 9b and 9c are copied from Davidson, 1869, Pl. XXXIII, figs. 26b and 26a, respectively.)

Orthis lenticularis (Wahlenberg), MATTHEW, 1892, Trans. Roy. Soc. Canada for 1891, vol. 9, sec. 4, No. 5, pp. 46–48, Pl. XII, figs. 9a–d. (Gives original and translation of Wahlenberg, 1821, p. 66, translations of Dalman, 1828, p. 132, and von Buch, 1834, p. 48, and copy of Salter, 1866, p. 339, and describes and discusses species. Specimens from Matthew's material are figured in this monograph, Pl. XCVIII, figs. 3, 3a–b, but as far as can be determined none of these specimens were figured by Matthew, 1892, Pl. XII, figs. 9a–d.)

Orthis lenticularis strophomenoides MATTHEW, 1892, idem, p. 49, Pl. XII, figs. 12a–b. (Characterized and discussed as a new variety. The specimens represented by Pl. XCVIII, figs. 1c and 2b, of this monograph, are typical of this proposed variety, but they are drawn from material in the collections of the United States National Museum, and are not the type specimens.)

Orthis lenticularis (Wahlenberg), MATTHEW, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, pp. 213–216, Pl. XVII, figs. 1a–d. (Text and figures copied from Matthew, 1892, pp. 46–48, Pl. XII, figs. 9a–d.)

Orthis lenticularis strophomenoides MATTHEW, 1903, idem, p. 217, Pl. XVII, figs. 4a–b. (Characterized. Figs. 4a–b are copied from Matthew, 1892, Pl. XII, figs. 12a–b, respectively.)

Orthis (*Orusia*) *lenticularis* (Wahlenberg), WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 273–276. (Described and discussed essentially as below, giving translation of Kayser's references, 1876, p. 9.

Matthew [1892, pp. 46–48], in his excellent review of the descriptions of this species, gives a translation of Wahlenberg's original description, together with the Latin; also the descriptions of Dalman [1828, p. 132], von Buch [1834, p. 48], and Salter [1866, p. 339].

He calls attention [1892, p. 47] to the fact that if the reader will compare the several descriptions of this species by the authorities named he will be surprised at the diversity they exhibit. This diversity, Matthew thinks, is due partly to the imperfect descriptions of the earlier writers, but chiefly to the remarkable variability of the species. Matthew recognizes the species in the Upper Cambrian, near St. John, New Brunswick, and has also distinguished three varieties. Through his kindness I had the opportunity of studying the types of the varieties.

Through M. Schmalensee, a collector in the Geological Survey of Sweden, I secured a large and fine series of this species from thin bands of limestone in the *Olenus* and alum shales on Oeland Island and at Hunneberg. I also collected a quantity of the shells in the Upper Cambrian of Manuels Brook, Newfoundland. From this material an attempt has been made to

select a series illustrating the great range of variation in form and surface markings, first, from Sweden; second, from Newfoundland; and third, from New Brunswick. I was not able to obtain satisfactory material from Wales, but Davidson's figures [1869, Pl. XXXIII, figs. 22–28] illustrate fully the peculiarities of the species as it occurs there.

The general form of the shell is fairly well shown by the series of figures on Plate XCVIII; also the great variation in surface characters. Only one specimen was found in which the two valves were united (Pl. XCVIII, figs. 6, 6a–c). The convexity of the two valves is subequal, the ventral being a trifle greater. The cardinal view (Pl. XCVIII, fig. 6c) shows how short the hinge line of both valves is in a specimen where the cardinal extremities are rounded. The side view shows the angle of slope of the areas of the two valves.

A very careful search of the casts of the interior was made for the purpose of illustrating the muscle scars and vascular markings, and in a few instances traces of these have been found. In one illustration (Pl. XCVIII, fig. 1e) the area (pseudospondylium) beneath the umbo of the ventral valve is outlined, also the main vascular sinuses; in another (Pl. XCVIII, fig. 1p), drawn from the cast of a small ventral valve, the area, main vascular sinuses, and the details of the umbonal cavity are clearly shown. The backward extension of the cast of the grooves occupied by the sinuses to the apex of the cavity is very distinct; also the area between them occupied by the path of advance of the scars of the adductor muscles. Matthew [1892, Pl. XII] illustrates some traces of the vascular markings and muscle scars, but they are almost too indefinite to be of value.

In a single specimen of the ventral valve from Oeland Island (Pl. XCVIII, fig. 1p) the cast of the umbonal cavity is nearly as sharp as in some specimens of *Eoorthis remnicha*. The cavity is tripartite (Pl. XCVIII, fig. 1c), the central division being occupied by the diductor muscle scars, and the two lateral divisions are continuous with the ridges representing the casts of the main vascular sinuses. I have been unable to secure any illustrations to show clearly whether there is a deltidium present or not. The delthyrium is clearly shown in several specimens. Casts of the interior of the dorsal valve from Newfoundland (Pl. XCVIII, figs. 2f and 2h) show the presence of crural plates that extend to the bottom of the valve; also short but very definite crura and small depressions beside the latter for the reception of the teeth of the ventral valve. A cast of the ventral valve (Pl. XCVIII, fig. 2d) shows that the dental plates extend to the bottom of the valve; and specimens from Sweden (Pl. XCVIII, figs. 1c and 1e) show that in certain individual ventral valves the dental plates and a transverse arching ridge sharply define the umbonal cavity.

The average size of the specimens from Oeland Island is about 5 by 6 mm. One dorsal valve is 7 by 9 mm. Those from Hunneberg average from 5 to 6 mm., with occasional shells 7 by 8 mm. In Newfoundland great numbers measure 4 by 5 mm., and some have a length of 10 mm. and a width of 12 mm. Matthew [1892, p. 48] states that the average size of the shells in the Acadian rocks is about 5 by 6 mm. Brögger [1882, p. 48] mentions an example from Töien, Christiania, Norway, measuring 10.5 mm. by 12.5 mm.

I have not attempted any detailed description of the species, as it is so variable in form and surface markings. An attempt was made to determine varieties in the material from Sweden and Newfoundland, but there was such a gradation in all of the characters upon which such differentiation might rest that it was finally abandoned. Matthew [1892, p. 48] considers that he has reason for establishing varieties among the New Brunswick forms. Whether these would be of value if a large amount of material were available for comparison is doubtful.

Kayser [1876, Pl. I, figs. 11 and 12] illustrates a shell that is apparently identical with *Orusia lenticularis*, which occurs in the sandstone at Tilcuya, Province of Jujuy, Argentina, in association with *Olenus*, *Agnostus*, etc. He also illustrates [1876, Pl. I, fig. 13] a dorsal valve of a small *Orthis* that in many respects looks more like *O. lenticularis* than figures 11 and 12 of the same work. I very much doubt if they represent this species; in fact, Kayser questions his identification by an interrogation mark. He says of the shell [1876, p. 9]:

> Another, much smaller, *Orthis* species occurs in the fine-grained sandstones of Tilcuya, associated with *Olenus*, *Agnostus*, *Arionellus*, *Theca*, and *Orthis saltensis*, which has just been described. The smaller *Orthis* species is

transversely oval in outline, with straight hinge edge, corresponding to the greatest breadth of the shell. The ventral valve is moderately arched, the dorsal somewhat less. The surface of both valves is covered with comparatively strong ribs, arranged in bundles. On the middle of the ventral valve there is an especially well-marked rib or bundle of ribs. Corresponding to this on the dorsal valve there is a well-marked sinus, limited on each side by a strong bundle of ribs.

The form just described agrees in the main so well with the figures given by Salter and Davidson of the small English form identified with Wahlenberg's *lenticularis* that I can hardly doubt its specific identity with the latter.

Of *Orthis* sp. Kayser remarks [1876, p. 9]:

Before me lies a cast from Tilcuya, representing a third *Orthis* species. It is almost equal in size to *O. saltensis*, but differs from it in outline, which is greatly prolonged transversely, the greatest breadth at the hinge edge, and the feeble winglike projection of the hinge corners. This last-named characteristic and the much larger dimensions also distinguish this fossil from *O. lenticularis*. The surface of the shell has been covered with very strong bundles of ribs.

Matthew [1892, pp. 48–49] has named three varieties of *Orusia lenticularis*. I find essentially the same forms in the collections from Sweden and Newfoundland. Two of the varieties, *Orusia lenticularis atrypoides* and *O. lenticularis lyncioides*, have been illustrated in this monograph from Matthew's type specimens. The third variety, *Orusia lenticularis strophomenoides*, occurs associated with specimens of *Orusia lenticularis* in the Swedish material, and does not appear to be of varietal value. It is illustrated in this monograph by Plate XCVIII, figures 1c and 2b.

Formation and locality.—**Upper Cambrian:** (**9f**) Limestones of the *Olenus* zone at Nœrsnæs, west of Christiania; (**323l**) with *Parabolina spinulosa* at Töien, about 1 mile (1.6 km.) northeast of Christiania; (**323m**) Étage 2b at Oslo, about 1 mile (1.6 km.) southeast of Christiania; (**323n** [Brögger, 1882, p. 48]) Étage 2b at Vestfossen, 10 miles (16.1 km.) west-southwest of Christiania; (**323o**)[a] Étage 2b, in the city of Christiania; (**323p**) Étage 2b at Slemmestad, about 3 miles (4.8 km.) southwest of Christiania; (**323q** [Brögger, 1882, p. 101]) Étage 2b at Kårtveit, in the Christiania region; (**323r**)[a] Étage 2b at Krekling, in Sandsvär; (**323s**)[a] Étage 2b at Gjögrefos, in Sandsvär; (**323t**) Étage 2b in Hedemarken, east of Lake Mjösen (Miösen), about 40 miles (64 km.) north-northeast of Christiania; (**323u**)[a] Étage 2b at Öxna (Öksna), valley of Glommen River; and (**323v** [*Davidson, 1869, p. 231*]) *at Egeberg (about 1.5 miles (2.4 km.) southeast of Christiana?);* all in Norway.

(**310a**) Shales of *Olenus truncatus* zone, Oeland Island; (**390n**) limestones of *Olenus* zone at Hunneberg, western boundary of the Province of Skaraborg; (**309m**) limestones forming 3c of the *Olenus* series at Alunbruk (alum works), southern part of Oeland Island; (**390o**) arenaceous shales at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad; and (**390p** [Davidson, 1869, p. 231]) at Kinnekulle, northeast of Lidköping, Province of Skaraborg; all in Sweden.

Drift bowlders of gray bituminous limestone at the following localities [Roemer, 1885, pp. 33 and 34]: (**386e**) Between Vistula and Elbe rivers, in Schleswig-Holstein and Mecklenburg-Schwerin; (**386f**) near Wismar, Mecklenburg-Schwerin; (**386g**) near Rostock, Mecklenburg-Schwerin; and (**386h**) near Meseritz, Province of Posen; all in Germany.

Upper *Lingula* flags at the following localities: (**318s**)[b] Ogof-ddu Cliff, Carnarvonshire; (**366s**) 5 miles (8 km.) east of Ffestiniog, Merionethshire; (**318t**)[b] Penmorfa Church, Tremadoc, Carnarvonshire; (**318u**)[b] Gwerny-y-Barcud; (**318v**)[b] Rhiwfelyn; (**318**)[b] Penmain Pool, west of Dolgelly, Merionethshire; (**318a**)[b] Criccieth, Carnarvonshire; and (**318b** [Davidson, 1869, p. 232]), near Portmadoc, Carnarvonshire; all in North Wales.

(**3**) Shaly limestone 300 feet (91.4 m.) above the *Paradoxides* zone; and (**6v**) shaly limestones 325 feet (99.1 m.) above the Middle Cambrian; both on Manuels Brook, Conception Bay, Newfoundland.

(**314i**) Shale picked up on beach in Smith Sound, Trinity Bay, Newfoundland.

(**10h**) Shale on small east branch of Barachois River, 0.75 mile (1.2 km.) north of the crossroad from Boisdale to Upper Leitches Creek; (**13q**) shales of the Bretonian division of Matthew's [1903, p. 45] section on Gillis Brook, East Bay; (**307h**)[c] in Division C3b? (possibly C3c) of Matthew's section, on McLeod Brook=Barachois River; (**307i**)[c] in Division C3b of Matthew's section on McNeil Brook, east of Mira River; (**307j**)[c] limestone in Division C3b? (possibly C3c) on East Bay, east of Bras d'Or Lake; and (**307l**)[c] limestone in Division C3b? (possibly C3c) on Gillis Brook; all in eastern Cape Breton, Nova Scotia.

Limestone lentils in black shales of Division C3a of Matthew's section at the following localities: (**308b** [Matthew, 1892, p. 48]) on Germaine Street, St. John; and (**308f**)[c] on King Street, St. John; both in St. John County, New Brunswick.

(**389b** [Kayser, 1876, p. 9]) Sandstone at Tilcuya, Province of Jujuy, Argentina, South America.

Middle Cambrian: (**55b**) Top of the Eldorado limestone [Walcott, 1908f, p. 184], west side of Secret Canyon, Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

(**320f**) Limestone at Andrarum, 20 miles (32 km.) northwest of Simrishamn, Province of Christianstad, Sweden.

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[a] Brögger, 1882, p. 4. [b] Davidson, 1868, p. 314. [c] Matthew, 1903, p. 216.

Orusia lenticularis atrypoides (Matthew).

Plate XCVIII, figure 5.

Orthis lenticularis atrypoides Matthew, 1892, Trans. Roy. Soc. Canada for 1891, vol. 9, sec. 4, No. 5, p. 48, Pl. XII, figs. 11a–b. (Characterized as a new variety; see below for copy. The specimen represented by fig. 11a is redrawn in this monograph, Pl. XCVIII, fig. 5.)

Orthis lenticularis atrypoides Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 217, Pl. XVII, figs. 3a–b. (Characterized. Figs. 3a–b are copied from Matthew, 1892, Pl. XII, figs. 11a–b, respectively.)

Orthis (*Orusia*) *lenticularis atrypoides* (Matthew), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 276. (Original characterization copied as below.)

The original description by Matthew follows:

This form is comparatively smooth, though the ventral valve is sometimes concentrically wrinkled. This valve is distinguished by a mediar ridge and somewhat flattened sides, and the dorsal valve has an unusually deep sinus. Size of the known examples, 6 by 6 mm., and 5 by 6 mm. for the two valves.

Formation and locality.—**Upper Cambrian:** (**308b** [Matthew, 1892, p. 48]) Limestone lentils in black shales of Division C3a of Matthew's section, Germaine Street, St. John, St. John County, New Brunswick, Canada.

Orusia lenticularis lyncioides (Matthew).

Plate XCVIII, figure 4.

Orthis lenticularis lyncioides Matthew, 1892, Trans. Roy. Soc. Canada for 1891, vol. 9, sec. 4, No. 5, p. 49, Pl. XII, figs. 10a–c. (Characterized as a new variety; see below for copy. The specimen represented by fig. 10a is redrawn in this monograph, Pl. XCVIII, fig. 4.)

Orthis lenticularis lyncioides Matthew, 1903, Geol. Survey Canada, Rept. Cambrian Rocks Cape Breton, p. 216, Pl. XVII, figs. 2a–c. (Characterized. Figs. 2a–c are copied from Matthew, 1892, Pl. XII, figs. 10a–c, respectively.)

Orthis (*Orusia*) *lenticularis lyncioides* (Matthew), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 277. (Original characterization copied as below.)

The original description by Matthew follows:

Distinguished by its sharp, strong, radiating ribs, large umbo, and high cardinal area. In some of the larger examples the radiating ribs become subordinate to and are replaced on the newer part of the shell by concentric striæ, reversing the usual position of the ribbed and the smooth parts of the shells of this species. Size of the valves about 6 by 8 mm.

I have illustrated a ventral valve from Matthew's material that is the most strongly marked. The ventral valves are similar to those from Newfoundland represented by Plate XCVIII, figures 2h and 2i.

Formation and locality.—**Upper Cambrian:** (**308b** [Matthew, 1892, p. 49]) Limestone lentiles in black shales of Division C3a of Matthew's section, Germaine Street, St. John, St. John County, New Brunswick, Canada.

Genus OTUSIA Walcott.[a]

Billingsella (*Otusia*) Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 246. (Mentioned as a new subgenus.)

Otusia Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 148. (Classification of genus.)

This name was proposed [1905a, p. 246] to include "*Orthis sandbergi*" of N. H. Winchell, which was the only species known at the time the genus was named. One new species, *Otusia utahensis*, has been added since. The generic and specific characters are included in the description of the species.

Otusia sandbergi (N. H. Winchell).

Plate XCIII, figures 4, 4a–d.

Orthis sandbergi N. H. Winchell, 1886, Fourteenth Ann. Rept. Geol. and Nat. Hist. Survey Minnesota, p. 318, Pl. II, figs. 8 and 9. (Described as a new species.)

Orthis (?) *sandbergi* Winchell, Walcott, 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, pp. 452–453, Pl. LXI, figs, 2, 2a–d. (Described and discussed as on p. 770. Figs. 2, 2a–d are copied in this monograph, Pl. XCIII, figs. 4, 4a–d, respectively.)

[a] Prior to the definition of the genus *Otusia* the type species was described under the genera *Orthis* N. H. Winchell [1886, p. 318] and *Orthis?* Walcott [1899, p. 452].

Billingsella (Otusia) sandbergi (Winchell), WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 246–247. (Described and discussed essentially as in preceding reference, p. 769, and as below.)

Shell small, transverse, subquadrate in outline, exclusive of the acute cardinal extremities. Valves slightly convex, with a straight hinge line longer than the greatest width of the shell; cardinal area narrow, but well developed on each valve and divided by a rather large open delthyrium.

The ventral valve slightly flattened at the cardinal extremities, rising toward the center with a convex triangular swelling, broadening from the narrow beak to the front; beak small, rounded, and extending slightly beyond the hinge line. Dorsal valve flattened at the cardinal extremities, with well-marked rounded ridges rising between them, and a rather broad, well-defined median sinus; beak very small, slightly encroaching upon the hinge line.

Surface marked by fine, regular, radiating striæ, between which one or more faint intermediate striæ are sometimes visible; under favorable conditions very fine concentric striæ can be seen, and there are also usually present more or less distinctly marked lines of growth.

Very little is known of the interior of the ventral valve. Two fragments of the posterior portion show a broad delthyrium, strong teeth, and a broad umbonal cavity opposite the delthyrium. In the ventral valve the area is narrow and divided by a broad delthyrium, which has a strong cardinal process that extends forward nearly three times the length of the area. Anteriorly, it rests on a broad ridge that extends forward, gradually broadening out and disappearing at the anterior margin of the shell.

In my former description [1899, p. 453] I stated that "the generic character of this species has not been fully ascertained, but the material from the Yellowstone National Park and specimens from the typical locality at Red Wing, Minnesota, lead me to think that this can not be referred to the genus *Billingsella*. It appears to be an *Orthis* of the *Plectorthis* group of Hall and Clarke." A closer study of this species and the forms referred to *Billingsella* led me [1905a, p. 246] to refer it to *Otusia* on account of its surface characters, the character of the delthyrium in the two valves, and the strong cardinal process and median ridge in the dorsal valve.

A comparison of the specimens of this species from the type locality at Red Wing, Minnesota, with those from the Yellowstone National Park shows the two shells to be specifically identical as far as the comparison of casts in sandstone can be made with well-preserved shells on the surface of limestone.

The specific name was given in honor of Dr. J. H. Sandberg, of Red Wing, Minnesota, who first called attention to the type locality of this species.

FORMATION AND LOCALITY.—**Upper Cambrian**: (86a) "*St. Croix sandstone*" *near Red Wing, Goodhue County, Minnesota.*

(302f) Upper part of the Gallatin formation, north side of Elk Pass, between Buffalo and Slough creeks, Yellowstone National Park, Livingston quadrangle (U. S. Geol. Survey), Montana.

OTUSIA UTAHENSIS n. sp.

Plate LXXXIX, figures 3, 3a–c.

This species is represented by several fragments of the two valves. One of the specimens, represented by figure 3, indicates the general outline of the ventral valve, and figure 3b that of the dorsal valve. The surface is marked by concentric lines and small ridges of growth and numerous fine, rounded, radiating ribs that increase by the division of the ribs as they are lengthened by the growth of the shell. A shallow median sinus occurs on the dorsal valve, and a rounded median ridge on the ventral valve.

The largest dorsal valve has a width of 9 mm. at the hinge line, with a length of about 6 mm.

The generic reference is made on account of the general resemblance of this form to *Otusia sandbergi* (N. H. Winchell). It differs from the latter in outline and in the rounded character of the ribs.

FORMATION AND LOCALITY.—**Middle Cambrian**: (31c) About 900 feet (274.3 m.) above the Brigham quartzite and 3,300 feet (1,005.8 m.) below the Upper Cambrian in the limestone forming 1b of the Ute limestone [Walcott, 1908f, p. 196], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County; (32e) limestone at the

same horizon as that of No. 31c, just south of the south fork of Paradise Dry Canyon (locally known as East Fork), east of Paradise, Cache County; and (33r) *limestones faulted against the Cambrian quartzites in a canyon about 1 mile (1.6 km.) east of Cricket Spring, Cricket Range (locally known as the Beaver River Range or the Beaver Mountains), northwest of Blackrock, Millard County;* all in Utah.

Genus WYNNIA Walcott.[a]

Wynnia WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 148. (Classification of genus.)

The description of the type species includes all that is known of this genus. The material is poor, but sufficient to indicate that the species belongs to an undefined genus. It differs from *Orthis* (restricted) in the presence of the large vascular sinuses of the ventral valve and pointed apex of the dorsal valve. The latter is of the type of the apex of the valves of *Nisusia festinata* (Billings). From *Billingsella* it differs in the absence of dental plates and deltidium in the ventral valve.

Type.—Orthis warthi Waagen.

The generic name is given in honor of Mr. Arthur B. Wynne, of the Geological Survey of India.

WYNNIA WARTHI (Waagen).

Text figures 68A–A′; Plate LXXXIX, figures 4, 4a–f.

Orthis warthi WAAGEN, 1891, Mem. Geol. Survey India, Paleontologia Indica, 13th ser., Salt Range Fossils, vol. 4, pt. 2, pp. 102–104, Pl. I, figs. 12–15, Pl. II, figs. 1 and 2. (Described and discussed as a new species. The specimen represented by fig. 12b is redrawn in this monograph, Pl. LXXXIX, fig. 4a. The specimen represented by fig. 14 is redrawn in the same position on Pl. LXXXIX (fig. 4b) of this monograph and in text fig. 68A′. Different views of the same specimen are shown in this monograph, Pl. LXXXIX, fig. 4, and text fig. 68A, both of which drawings are of the same shell in the same position. The text figures are the correct representations in each case. Pl. II, figs. 2a, 2b, and 2c, are copied in this monograph, Pl. LXXXIX, figs. 4e, 4d, and 4f, respectively.)

FIGURE 68.— *Wynnia warthi* (Waagen). A, Cast of interior of a ventral valve (× 4). The shell was compressed laterally and hence the muscle scars and sinuses are crowded toward the center. A′, Posterior view of same specimen, showing broken-off beak.

The specimen from which figures 68A and 68A′ are drawn is incorrectly figured on Plate LXXXIX, figures 4 and 4b, of this monograph, and is the specimen figured by Waagen [1891, Pl. II, fig. 14]. It is from the upper portion of the "*Neobolus* beds" at Chél Hill, Salt Range, India (Geol. Survey India, Cat. No. 4/124).

Shell small, biconvex, subcircular to broad oval in outline. Exterior surface unknown. Cast of interior of ventral valve strongly convex. Apex slightly incurved over a rather high area that slopes forward at an angle of about 45° to the hinge line. The area is formed of two narrow sides separated by a large triangular delthyrium without traces of a deltidium; the narrow, elongate sides are slightly concave and have in the cast a narrow raised margin next to the delthyrium. The dorsal valve is less convex than the ventral, its area slopes forward from the hinge and at the apex of the valve bends slightly forward, giving an effect somewhat like that of the ventral valve of *Nisusia festinata* (Billings), only very much reduced. The casts of the interior of the ventral valve show two strong vascular sinuses and a faintly defined muscle area. This has an outline not unlike that of the diductor scars in the ventral valve of *Billingsella romingeri* (Barrande) (Pl. XC, fig. 2g). The large main vascular sinuses also extend forward in the same manner in the two species. The illustrations of the interior of the ventral valve of *Wynnia warthi* (Pl. LXXXIX, figs. 4 and 4a) fail to show the outline of the muscle area as well as it is shown in the specimen represented by figure 4, so I have inserted text figures 68A and 68A′, which are drawn from the same specimen.

The casts of the interior of the dorsal valve show a median depression with a few radiating lines, and a few very fine radiating lines extending from the apex a short distance forward. In addition, by reflected light, the outlines of the anterior and posterior adductor scars can be seen on the posterior half of the valve (Pl. LXXXIX, fig. 4c).

The longest ventral valve in the collection has a length and width of 9 mm. The dorsal valve is a little shorter.

[a] Prior to the definition of the genus *Wynnia* the type species was placed under *Orthis* [Waagen, 1891, p. 102].

Observations.—Waagen [1891, p. 102] describes this shell at length and also gives a number of illustrations that are more or less diagrammatic. Through the courtesy of Doctor Holland, the director of the Geological Survey of India, I have been able to study the type specimens. I can not see as much in them as Waagen did, but as far as my observations go they agree with his, except that the characters shown on the specimen represented by his figure 15 [1891, Pl. I] and figure 1 [1891, Pl. II] appear to me to be the result of fracture caused by compression of the original shell and not to be muscle scars, etc., as interpreted by Waagen [1891, Pls. I and II].

The differences between this shell and the nearest known forms are mentioned under the description of the genus (see p. 771).

The specific name is given in honor of Dr. H. Warth, of the Geological Survey of India.

FORMATION AND LOCALITY.—**Middle Cambrian**: (357d [Waagen, 1891, p. 104]) "Concretionary shales of the Khussak group" at several localities between Chél Hill and Kiura (Khewra), eastern part of Salt Range, India.

Subfamily EOORTHINÆ Walcott.

Genus EOORTHIS Walcott.[a]

[ἠώς, dawn; and ὀρθός, straight.]

Not *Plectorthis* HALL and CLARKE, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, pp. 194–195. (Characterized as a new genus; see below for copy. This genus, as now restricted, is not known to occur in the Cambrian.)

Orthis (*Plectorthis*) WALCOTT [not (HALL and CLARKE)], 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 257–259. (Original characterization copied and genus discussed somewhat as below.)

Plectorthis GRABAU and SHIMER (in part) [not HALL and CLARKE], 1907, North American Index Fossils, vol. I, pp. 250 and 251. (Characterized. Includes both true *Plectorthis* and *Eoorthis*.)

Eoorthis WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 102–104. (Described and discussed as below as a new genus.)

Eoorthis WALCOTT, 1908, idem, vol. 53, No. 4, Pl. XI, and pp. 142 and 148. (Classification of genus.)

In their subdivision of the genus *Orthis* Dalman, Hall and Clarke [1892c, p. 192] restricted the genus *Orthis* to the group of which *Orthis callactis* Dalman is the type, and, among American forms, *Orthis tricenaria* of the Trenton and Hudson faunas. These forms show the existence of a transverse apical plate in the delthyrium of the ventral valve. The name *Plectorthis* was proposed for a second group, of which *Orthis plicatella* was made the type (Pl. XCVI, figs. 4, 4a), and of this the authors [1892c, p. 194] say:

> This is a persistent form, which in American faunas, so far as known, is limited to the Trenton and Hudson River formations. While it retains the strong external ribs of the typical *Orthis*, these are not invariably simple (*O. fissicosta* Hall; *O. triplicatella* Meek; *O. æquivalvis* Hall [not Davidson]; *O. jamesi*, Hall) (Pl. XCVI, figs. 5, 5a–c). The cardinal area of the pedicle valve is comparatively low and the valves are subequally convex. In the interior, the character of the muscle scars, dental lamellæ and cardinal process is essentially the same as in group I (*Orthis*), and the minute structure of the shell appears to be in precise agreement with that of *O. calligramma* though no evidence of tubulose costæ has been observed. In *Orthis jamesi*, which is placed in this association, there is occasionally a deviation toward the resupinate contour exemplified in group IV (*Orthis subquadrata*) and group V (*Orthis sinuata*).

In the Cambrian faunas I find a group of species intermediate between the typical forms of *Billingsella* and of *Orthis*, as limited by Hall and Clarke [1892c, p. 193], which I have referred for a long time to Hall and Clarke's *Plectorthis*, placing that genus as a subgenus of *Orthis*.

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[a] The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Eoorthis* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record for the species taken up in this monograph the following mere generic references are listed:

Orthis de Verneuil and Barrande [1860, p. 532].
Orthis Kjerulf [1865, p. 1].
Orthis Barrande [1868a, p. 99; 1868b, p. 690].
Orthis Meek [1870, p. 425; 1872, p. 295].
Orthis Mallada [1875, p. 31].
Orthis Kayser [1876, p. 8].
Orthis Remele [1881, p. 69].
Orthis Brögger [1882, p. 48].
Orthis Kayser [1883, p. 34].
Orthis Remele [1885, p. 6].
Orthis Roemer [1885, pp. 36, 37, and 38].
Orthis Winchell [1886, p. 317].
Orthis Gagel [1890, pp. 10 and 34].
Orthisina? Matthew [1892, p. 49].
Strophomena Matthew [1893, p. 102].
Orthis Pompeckj [1896a, p. 4; 1896b, p. 514].
Rafinesquina? Schuchert [1897, p. 338].
Orthis Kayser [1897, p. 280].
Orthis? Walcott [1899, p. 451].
Orthis Pompeckj [1902, p. 7].
Orthis Weller [1903, p. 113].
Orthis? Etheridge [1905, p. 249].
Orthis (*Plectorthis*) Walcott [1906, p. 570].
Orthis (*Plectorthis*) Moberg and Segerherg [1906, p. 69].
Nisusia Walcott [1908d, p. 97] (by mistake).

This Cambrian group of shells which I now refer to a distinct genus may be defined as follows, the type of the genus being *"Orthis remnicha"* Winchell (Pls. XCI and XCII):

Diagnosis.—Shells subquadrate to transversely elongate; with or without median fold and sinus; valves subequally convex. Hinge line straight, usually forming nearly the greatest diameter of the shell. Cardinal extremities broadly angular, rarely acuminate. Surface with radiating ribs and striæ which may be crossed by concentric growth lines and striæ. The ribs increase by interpolation.

The ventral valve has the umbo more or less elevated over a hinge line, the apex acute and usually incurved. The area is rather broad, flat or incurved, and transversely striated. Teeth short and supported by dental plates that extend to the bottom of the valve, bounding a space (pseudospondylium) including the main vascular sinuses and area of attachment of the adductor muscle scars. Delthyrium open or partly closed by a convex deltidium. The adductor muscle scars are included within a narrow median area beneath the umbo on each side of the median line, and the diductors in a more or less flabelliform area outside of the main vascular sinuses. Pedicle scars unknown.

Dorsal valve with low umbo and slightly incurved apex; area well developed, with a broad delthyrium. Deltidial cavity with a straight, simple, cardinal process. Dental sockets small, with short crura. The adductor muscle scars are small, the anterior being nearer the median ridge, which usually extends forward from the base of the cardinal process.

Shell structure dense, with a minutely granular groundmass. Sections vertical to the outer surface, however, show a few laminations of growth, but no fine fibers; sections on the plane of the surface show a few coarse irregular fibers resembling matted wood pulp; a dense granular groundmass that is penetrated here and there by irregular openings of varying size. The openings or pores appear to be confined to one or more lamellæ of the shell and not to pass through it from inner to outer surface, as in *Orthis* (*Dalmanella*) *parva* and allied punctate orthoids. The openings are usually indicated by minute scattered dark spots.

Type.—*Orthis remnicha* Winchell.

Observations.—The Cambrian species referred to *Eoorthis* have relatively thin shells that retain on the interior surfaces but slight traces of the muscle scars and vascular markings, except in the umbonal cavity. *Eoorthis* may be distinguished from *Orthis* (s. s.) by (1) its ribs increasing by interpolation; (2) its strongly defined pseudospondylium; (3) its relatively thin shell; and (4) its dense, nonfibrous shell structure. The last three characters also distinguish it from *Plectorthis* and other subgenera of *Orthis*. *Eoorthis* may be considered as the possible connecting link between *Billingsella* and the orthoids of the Ordovician.

The geological range of *Eoorthis* is from the upper portion of the Middle Cambrian through the Upper Cambrian and into the lower portion of the Ordovician.

Two of the species from strata referred to the Middle Cambrian are represented by material too imperfect for specific description; they occur with *Paradoxides* in Bohemia, and it is not improbable that they will be found to belong to some other genus. The remaining one of the three species referred to the Middle Cambrian is *E. wichitaensis*, which occurs in the upper portion of the Middle Cambrian and base of the Upper Cambrian, and *E. hastingsensis*, which occurs in the Middle Cambrian (*Paradoxides* zone).

Eoorthis agreste (Walcott).

Plate LXXXIX, figures 6, 6a.

Orthis (*Plectorthis*) *agreste* Walcott, 1906, Proc. U. S. Nat. Mus., vol. 30, p. 570. (Described as below as a new species.)

Shell transverse, subsemicircular; a ventral valve 9 mm. in length has a width of 12 mm. and a hinge line 10.5 mm. in length; ventral valve moderately and regularly convex, with the apex curved down to an area that is slightly inclined forward from the hinge line. The details of the cardinal area are unknown.

Surface marked by rounded radiating ribs and interspaces, 6 ribs in a space of 3 mm. near the front margin; a few of the ribs bifurcate, but most of them extend from the umbo to the front margin; the ribs are crossed by fine concentric striæ and strong lines of growth.

Observations.—This shell is characterized by its regular convexity and the uniformity of the rounded, radiating ribs.

FORMATION AND LOCALITY.—**Middle Cambrian**: (C28) Upper part of the thin-bedded gray limestone at the base of the Changhia formation [Blackwelder, 1907a, p. 32 (first list of fossils), and fig. 6 (bed 20), p. 25] 1 mile (1.6 km.) east-southeast of Changhia, Shantung, China.

EOORTHIS ATAVA (Matthew).

Plate XCV, figures 7, 7a–b.

Strophomena atava MATTHEW, 1893, Trans. Roy. Soc. Canada for 1892, 1st ser., vol. 10, sec. 4, No. 7, pp. 102–103, Pl. VII, fig. 8a–f. (Described and discussed as a new species; see below for copy. The specimens represented by figs. 8c, 8a, and 8b are redrawn in this monograph, Pl. XCV, figs. 7, 7a–b, respectively.)

Rafinesquina? atava (Matthew), SCHUCHERT, 1897, Bull. U. S. Geol. Survey No. 87, p. 338. (Merely changes generic reference.)

Orthis (Plectorthis?) atava (Matthew), WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 259–260. (Original description copied and species discussed as below.)

Strophomena? atava Matthew, MOBERG and SEGERBERG, 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), Pl. II, figs. 7, 7a–b. (No text reference. Figs. 7, 7a–b, in common with the remaining figures on Pl. II of Moberg and Segerberg's paper, were copied from a preliminary photograph of Pl. XCV of this monograph.)

The original description by Matthew follows:

Narrow semicircular. Valves slightly arched, rather wider than the hinge line, compressed at the cardinal angles; sides of the valves nearly straight behind, regularly rounded in front.

Ventral valve moderately convex, highest and somewhat angulated at the middle of its length. Umbo inconspicuous and appressed to the very narrow area.

Dorsal valve somewhat concave, especially toward the umbo, which is depressed to the general level of the valve.

The interior of the ventral valve has characters intermediate between those of *Orthis* and *Strophomena*. The ridges inclosing the cardinal muscles are shorter and closer at their extremities than in *Strophomena*, and the scar of the adductor muscle is broader and shorter, but extends halfway to the front of the valve. There is a low, sharp ridge at the umbo between the branches of the posterior cardinal muscle, and the ventral cavity is faintly outlined in front. Another cast of the ventral valve of a larger individual, perhaps of this species, shows the impressions of the muscles more distinctly; in this the impression of the adductor muscle is much nearer to the hinge, being about two-thirds from the front of the valve. There is a low callus in front of the imprint of the adductor muscle.

A partly decorticated example of the dorsal valve exhibits a small bifid scar at the hinge line, due to the adductor muscle. There is no median ridge, such as is found in *Orthis*, the median sinus being almost obsolete. In front of the impression of the adductor muscle is a small, low callus.

Sculpture: This consists of sharply raised, rounded, radiating ridges, slightly crenulated by obscure, transverse lines. These ribs are of varying size, every third or fifth rib being larger than the others. These large ribs extend outward from the umbo, and the smaller ones are intercalated between them, or spring from them. On the dorsal valve there are two main ribs in the sinus of the valve and three others extending to the lateral margins; smaller ribs are intercalated between these. On each side of the group of ribs on the middle third of the shell are four fainter, but more strongly arched groups of ridges which throw off minor ridges at the back, directed toward the lateral margins. On the ventral valve the small ribs are almost all intercalated and do not spring from the back of the primary ribs, as in those of the dorsal valve.

Size: Length, 12 mm.; width, 14 mm. Height of area of dorsal valve, 0.5 mm.; of ventral valve, 1 mm. A valve supposed to be of this species is 15 mm. long and 19 mm. wide.

Observations.—With the available data this species appears to be quite as near to *Eoorthis* as any described genus. It does not appear to belong with the typical forms of *Strophomena* or *Rafinesquina*. The surface ribs, increasing by interpolation, and possibly bifurcation, and the form of the pseudospondylium in the ventral valve, strongly suggest a relationship with *Eoorthis*. It will probably require better preserved material to determine satisfactorily the correct generic reference for the species.

FORMATION AND LOCALITY.—**Upper Cambrian**: (308a [Matthew, 1893b, p. 103]) Dark shales of division C3a of Matthew's section of the St. John formation, Navy Island, St. John Harbor, St. John County, New Brunswick, Canada.

Eoorthis bavarica (Barrande).

Plate XCVII, figure 4.

Orthis bavarica Barrande, 1868, Faune silurienne des environs de Hof, en Bavière, p. 99, fig. 76. (Described in French as a new species; see below for translation. Fig. 76 is reproduced in this monograph, Pl. XCVII, fig. 4.)

Orthis bavarica Barrande, 1868, Neues Jahrb. für Mineralogie for 1868, p. 690, unnumbered plate, fig. 76. (Copy of preceding reference.)

Orthis sp., Pompeckj, 1896, Tremadoc Fossilien bei Hof, p. 4. (Discussed in German; see below for statement of probable relationships.)

The original description by Barrande follows:

This very rare species is only represented by two specimens, reduced to a single valve, of which the less imperfect of the two is figured. It has been deformed by compression, but we recognize that it represents the ventral valve, the beak of which appears remarkably acute and projecting, doubtless by reason of compression. This valve shows a barely indicated sinus, very shallow, but rather broad on the frontal contour. The surface is ornamented with projecting longitudinal striæ, close together, most of which end at the beak, but some are bifurcated in their extension. A trace of some concentric striæ is seen.

Length, 14 mm.; breadth, somewhat reduced by compression, 9 mm.

Pompeckj [1896a, p. 4] mentions the finding of two impressions of a species of *Orthis* agreeing in form with *E. bavarica* (Barrande) at Neuhof, near Hof. The species differs in having a sharper, higher rib intercalated between every three or four finer ribs, while the ribs of *E. bavarica* are all equally strong. The variation in the strength and number of the ribs in species of *Eoorthis* is often so great that it may be that the form mentioned by Pompeckj [1896a, p. 4] will prove to be only a variation of *Eoorthis bavarica*.

From the description and illustration, I think this species should be referred to *Eoorthis*.

Formation and locality.—Passage beds between the Upper Cambrian and the Ordovician: (303c [*Barrande, 1868a, p. 99*]) *suburbs of Hof;* and (303f [Pompeckj, 1896a, pp. 7 and 8]) railway cut near Schellenberg, a little distance back of the railway station at Neuhof, near Hof; both in Bavaria, Germany.

Eoorthis christianiæ (Kjerulf).

Plate XCV, figures 1, 1a–h.

Orthis christianiæ Kjerulf, 1865, Veiviser ved Geologiske Excursioner i Christiania Omegn, p. 1 and figs. 8a–c, p. 3. (Locality given in Norwegian.)

Orthis christianiæ Kjerulf, Brögger (in part), 1882, Die silurischen Etagen 2 und 3, p. 48, Pl. X, figs. 14a–c. (Mentions specimens from both the *Ceratopyge* slate and *Ceratopyge* limestone and thus probably includes the two species, *Eoorthis christianiæ* and *E. daunus*. See below.)

Orthis (*Plectorthis*) *christianiæ* (Kjerulf), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 260–261. (Discussed somewhat as below.)

Orthis (*Plectorthis*) *christianiæ* (Kjerulf), Moberg and Segerberg (in part), 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), p. 69, Pl. II, figs. 1, 1a–h; Pl. III, figs. 12 and 13. (Described and discussed in Swedish. Includes *Eoorthis daunus* and *E. tullbergi*. Figs. 1, 1a–h, in common with the remaining figures on Pl. II of Moberg and Segerberg's paper, were copied from a preliminary photograph of Pl. XCV of this monograph.)

The general form and character of this shell as it occurs in the shales are shown by the figures illustrating it. It appears to differ from any described species in the peculiarity of the bifurcation of the radiating ribs. In all the species I have referred to *Eoorthis* the increase in the number of ribs is by interpolation and not by true bifurcation. In *E. christianiæ* the increase is by both methods, as shown by figures 1a, 1b, and 1g. The reference to *Eoorthis* is somewhat doubtful, as there are not sufficient data to base a reference on the characters of the interior, cardinal areas, or convexity of the valves.

I have received a large number of specimens from Norway and Sweden labeled "*Orthis christianiæ.*" After a study of all the available material only the shells from the argillaceous shale of Russelökken and Töien, Norway, and of Oeland Island, Sweden, appear to belong to the species. The shells in the *Ceratopyge* limestone (*Eoorthis daunus*) have ribs that increase in number by interpolation of ribs in the interspaces between the older ribs, and a second species (*E. wimani*), that occurs in both the shale and the limestone, has simple ribs with few

interpolated beyond the umbo. Another transverse form has simple strong ribs that increase in number by the interpolation of a few new ribs.

Brögger's illustrations of this species [1882, Pl. X, figs. 14a–c] suggest *E. daunus* more than the typical form of *E. christianiæ*, as I understand and interpret it. "*Orthis parva*" Dalman (Pl. XCVI, figs. 6, 6a–g) has sometimes been referred to *E. christianiæ*.

Gagel [1890, p. 34] described the form usually found in the limestone, stating that the surface is covered with strong, dichotomous ribs. He found it in drift blocks of the *Ceratopyge* limestone near Belschwitz, East Prussia; and of glauconitic limestone near Prussian Holland, and near Wehlau, East Prussia, Germany.

Roemer [1885, p. 36] calls attention in his description of the drift in the North German plain to the fact that Remelé [1885, pp. 695–698] was the first to identify with certainty blocks of the *Ceratopyge* limestone of Sweden in the drift of Germany, the presence of a form like *E. christianiæ* being part of the evidence. This shell is probably *E. daunus*. Roemer [1885, p. 36] states in description of the *Ceratopyge* limestone that a small "*Orthis (? Orthis christianiæ* Kjerulf)" predominates.

The specific name is derived from Christiania, Norway.

Formation and locality.—**Upper Cambrian:** (**323x**) *Ceratopyge slate, at Russelökken;* and (**323y**) *Ceratopyge* slate at Töien; both near Christiania, Norway.

(**310d**) *Ceratopyge* slate, at Borgholm, Oeland Island, Sweden.

(**309e**) Shales of the *Acerocare* zone at Åkarpsmölla, midway between Kågeröd and Röstånga, Province of Malmöhus, Sweden.

Eoorthis daunus (Walcott).

Plate XCV, figures 2, 2a–c.

Orthis sp. Remelé, 1881, Zeitschr. Deutsch. geol. Gesell., Bd. 33, p. 696. (Characterized and compared in German.)

Orthis christianiæ Brögger (in part) [not Kjerulf], 1882, Die silurischen Etagen 2 und 3, p. 48, Pl. X, figs. 14a–c. (Mentions specimens from both the *Ceratopyge* slate and *Ceratopyge* limestone and thus probably includes the two species, *Eoorthis christianiæ* and *E. daunus*.)

Orthis christianiæ Roemer [not Kjerulf], 1885, Paleontologische Abhandlungen von Dames und Kayser, Bd. 2, Hft. 5, pp. 36, 37, and 38. (Mentioned in German, in review of literature.)

Orthis christianiæ Remelé [not Kjerulf], 1885, Katalog der beim intern. Geologen-Congress zu Berlin ausgestellten Geschiebesammlung, p. 6. (Locality mentioned.)

Orthis christianiæ Gagel [not Kjerulf], 1890, Beitr. zur Naturkunde Preussens, von Physikal.-oekonom. Gesell. Königsberg, No. 6, pp. 10 and 34, Pl. II, figs. 22a–b. (Described and new localities mentioned in German.)

Orthis christianiæ Pompeckj [not Kjerulf], 1902, Neues Jahrb. für Mineralogie, Bd. 1, p. 7. (Occurrence mentioned, in German.)

Orthis (Plectorthis) daunus Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 261. (Characterized as a new species.)

Orthis (Plectorthis) daunus Walcott, Moberg and Segerberg, 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), p. 69, Pl. II, figs. 2, 2a–c. (Characterized in Swedish. Figs. 2, 2a–c, in common with the remaining figures on Pl. II of Moberg and Segerberg's paper, were copied from a preliminary photograph of Pl. XCV of this monograph.)

The illustrations show the principal characters of this species. It differs from *Eoorthis christianiæ* in having simple ribs that increase in number toward the front and lateral margins of the shell by interpolation of new ribs; no true bifurcation of the ribs was observed. A strong median sinus occurs on specimens of the dorsal valve in both shale and limestone. The shell is fibrous and impunctate. No traces have been seen of the fine, rounded, radiating striæ that occur on the broader ribs and interspaces of *E. christianiæ*. This species differs from *E. wimani* in its more transverse form and less simple ribbing of the shell.

Moberg and Segerberg [1906, pp. 69–70] regard this form as one of the variations of *E. christianiæ*. This may be a correct view, but I am not prepared, after a careful study of the material before me, to accept it. To support such an interpretation we should find, in a very full series of *E. christianiæ* from the same bed or matrix, the gradations or varieties that I have named *tullbergi* and *daunus*.

Formation and locality.—**Passage beds between the Upper Cambrian and Ordovician:** (**386**) Drift blocks of *Ceratopyge* limestone near Belschwitz; (**386a**) drift blocks of "Glauconite limestone" near Prussian Holland,

90 miles (145 km.) south-southwest of Konigsberg; and (**386b**) drift blocks of "Glauconite limestone" near Wehlau, 30 miles (48 km.) east of Konigsberg; all [Gagel, 1890, p. 34] in East Prussia, Germany.

(**323z**) *Ceratopyge limestone at Töien, near Christiania;* and (**8x**) *Ceratopyge* limestone at Slemmestad, about 3 miles (4.83 km.) southwest of Christiania; both in Norway.

(**323h**) Blue *Ceratopyge* limestone at Vestfossen; and (**323f**) lower part of the *Ceratopyge* limestone at Vestfossen; both [Brögger, 1882, p. 17] 10 miles (16.1 km.) west-southwest of Christiania, Norway.

(**310j**) *Ceratopyge* limestone at Borgholm; and (**310** [Moberg and Segerberg, 1906, description of Pl. III]) *Ceratopyge* limestone (zone 4) at Ottenby; both on Oeland Island, Sweden.

Eoorthis desmopleura (Meek).

Plate XCVI, figures 1, 1a–r.

Not *Orthis coloradoensis* Shumard, 1860, Trans. Acad. Sci. St. Louis for 1856–1860, vol. 1, p. 627. (Referred in this monograph to *Billingsella.*)

Orthis coloradoensis Meek [not Shumard], 1870, Proc. Am. Philos. Soc., vol. 11, No. 84, p. 425. (Described as a new species.)

Orthis desmopleura Meek, 1872, U. S. Geol. and Geog. Terr., Geol. Survey Wyoming, Prelim. Rept., p. 295. (Merely proposed as a new specific name, *coloradoensis* being preoccupied.)

Orthis (*Plectorthis*) *desmopleura* (Meek), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 261. (Characterized.)

This shell has the general form and external characters of *E. wichitaensis* (Walcott). It differs in being less convex and in the details of the radiating ribs. The illustrations of the two species will serve as a basis of comparison. *Eoorthis desmopleura* differs from *E. remnicha* (N. H. Winchell) in its uniformly smaller size, less convexity, and in the details of the radiating ribs. The ribs have a wide range of variation, but when from the same character of matrix they are all of the same type and the shells grade from one to the other. The ventral valves of young shells 2 to 3 mm. long are highly convex and usually appear to be a little longer than wide; if in such shells the surface striæ are in sharply elevated fasciculæ, the result is to all appearances a rhynchonelloid shell.

The interior of the ventral valve shows a narrow area, broad delthyrium, spondylium almost free from the bottom of the valve, and a median septum that may have supported the front end of the spondylium. In young and strongly convex shells the spondylium is narrow and very strongly defined. The narrow area of the dorsal valve is divided by a broad delthyrium, in the center of which is a very slightly developed cardinal process.

The Wyoming variety of this species occurs in abundance in the Bighorn Mountains. The specimens illustrated on Plate XCVI show the characteristic features of the species as it occurs in Colorado, and also some phases of it not observed there. The typical form is illustrated by figure 1h. For the variety the name of *E. desmopleura nympha* is used (Pl. XCVI, fig. 2).

Eoorthis hamburgensis (Walcott) [1884b, p. 73] is closely related to *E. desmopleura* and may be identical with it. *Eoorthis melita* (Hall and Whitfield) [see *Leptæna melita* Hall and Whitfield, 1877, p. 208] from the Pogonip Lower Ordovician limestone is near to the less convex, more evenly striated forms of *E. desmopleura*. It is probably not more than a variety of the latter. Schuchert's reference of the species *L. melita* to *Dalmanella* [1897, p. 202] does not appear to be correct, as it has the pseudodeltidium of *Eoorthis*.

Formation and locality.—**Lower Ordovician:** (**360f**) *Siliceous limestone at Glen Eyre, Queens Canyon, northeast of Manitou;* (**360a**) red siliceous limestone on west side of Trout Creek below Bergen Park, 7 miles (11.2 km.) north-northwest of Manitou; (**186** and **186a**) near line of contact between red and gray Ordovician limestone, in siliceous red limestone about 30 feet (9.1 m.) above the pre-Cambrian rocks, Williams Canyon, Manitou; (**187**) red siliceous limestone 105 to 122 feet (32 to 36.7 m.) above the pre-Cambrian rocks, 2 miles (3.2 km.) below Manitou Park Hotel; and (**360**) red siliceous limestone near Colorado Springs; all in El Paso County, Colorado.

(**105t**) Limestone [Walcott, 1908f, p. 173] at the summit of Notch Peak, House Range, Millard County, Utah.

(**185z**) Limestones at the base of the Lower Ordovician [Walcott, 1908f, p. 191] in Blacksmith Fork Canyon, about 9 miles (14.4 km.) east of Hyrum, Cache County, Utah.

Passage beds between the Upper Cambrian and the Ordovician: (**34g**) Limestone about 1,000 feet (305 m.) above the valley on the east side of the Fish Spring Range, just west of the high point southwest of the J. J. Thomas ranch, Tooele County, Utah.

Upper Cambrian: (**30w**) Drift bowlder of limestone supposed to have come from 1a of the Notch Peak limestone on Notch Peak [Walcott, 1908f, p. 175], found about 2 miles (3.2 km.) south of Marjum Pass, House Range [Walcott, 1908f, Pl. XIII], Millard County; (**331**) limestones in pass between the Pavant Mountains and the Canyon Range, a few hundred yards east of the divide, on the road between Holden and Scipio, Millard County; and (**54r**) drift pieces of limestone from the west slope of the Wasatch Range, east of the Lakeview ranch, about 5 miles (8 km.) north of Brigham, Boxelder County; all in Utah.

(**54b**) About 1,200 feet (365.8 m.) above the Middle Cambrian and 25 feet (7.6 m.) below the top of the Upper Cambrian in the upper part of the limestone forming 1 of the St. Charles formation [Walcott, 1908f, p. 191]; (**54c**) about 1,100 feet (335.3 m.) above the Middle Cambrian and 120 feet (36.6 m.) below the top of the Upper Cambrian, in the central part of the limestone forming 1 of the St. Charles formation [Walcott, 1908f, p. 192]; and (**54d**) about 1,050 feet (320 m.) above the Middle Cambrian and 175 feet (53.3 m.) below the top of the Upper Cambrian in the lower part of the limestone forming 1 of the St. Charles formation [Walcott, 1908f, p. 192]; all in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

(**158**) Limestones north of East Gallatin River, near Hillsdale; and (**340b**) limestone at the mouth of Fourmile Creek; both in the Threeforks quadrangle (U. S. Geol. Survey), Gallatin County, Montana.

(**327**) Arenaceous limestone east of Gold Camp, in the Caballos Mountains, New Mexico.

(**14k**) Limestone on Wolf Creek, 15 miles (24.2 km.) west-southwest of Sheridan, Bighorn Mountains; and (**168**) limestone on north side of Tepee Creek, beside the road from Sheridan to Dome Lake, Bighorn Mountains; both in Sheridan County, Wyoming.

(**346b**) Conococheague limestone, 2.75 miles (4.4 km.) south of Mercersburg, Franklin County, Pennsylvania.

Specimens that are somewhat doubtfully referred to this species occur at the following localities:

Upper Cambrian: (**152**) Limestone on ridge between Churn and Cottonwood Canyons, west side of Bridger Range; and (**154**) limestone in hill on west side of Dry Creek, opposite mouth of Pass Creek, about 5 miles (8 km.) north of Hillsdale, Threeforks quadrangle (U. S. Geol. Survey); both in Gallatin County, Montana.

Upper? Cambrian: (**306**) Sandy limestone on Gravel River, eastern slope of the Rocky Mountains, in the Mackenzie River basin, British Columbia.

Eoorthis desmopleura nympha (Walcott).

Plate XCVI, figure 2.

Orthis (*Plectorthis*) *desmopleura nympha* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 262. (Characterized as below as a new variety.)

This variety is based on strongly convex ventral valves in which the surface is marked by fine radiating striæ, separated into bands of 3 to 6 striæ by stronger and more elevated striæ. Some shells show concentric lines and often ridges of growth that give an imbricated appearance to the portion of the surface beyond the umbo.

Formation and locality.—**Lower Ordovician:** (**186**) Near line of contact between red and gray Ordovician limestone, in red siliceous limestone about 30 feet (9.1 m.) above the pre-Cambrian rocks, Williams Canyon, Manitou, El Paso County, Colorado.

Upper Cambrian: (**168**) *Limestone on north side of Tepee Creek, near the road from Sheridan to Dome Lake, Bighorn Mountains, northern Wyoming.*

Eoorthis? diablo (Walcott).

Plate XCIII, figure 3.

Orthis (*Plectorthis*) *diablo* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 262. (Described as below as a new species.)

This species is founded on a small, transverse shell that is marked by a few prominent radiating costæ that extend from the umbo to the margin of the shell. In the cast the costæ have a sharp summit and slope evenly to a narrow space between them.

A ventral valve 9 mm. in height has a width of 14 mm., which is about the average proportion of the specimens in the collection. The casts of the ventral valve show a rather low area divided by a delthyrium, the inner angles of which have a rather strong tooth. The dental plates extend backward farther than in most species of the genus, becoming attached to the bottom of the valve only near the teeth, and not extending forward as in *Eoorthis remnicha* to form a pseudospondylium. None of the specimens in the half dozen shells in the collection

show the muscular or vascular markings. There may or may not be a mesial depression on either valve. The reference of this species to *Eoorthis* is made with much reservation.

FORMATION AND LOCALITY.—**Upper Cambrian: (81b)** "*St. Croix sandstone,*" *near Devils Lake, Sauk County;* and **(83)** "St. Croix sandstone," near Trempealeau, Trempealeau County; both in Wisconsin.

EOORTHIS DORIS (Walcott).

Plate XCVII, figures 13, 13a.

Orthis (*Plectorthis*) *doris* WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 262–263. (Described and discussed as below as a new species.)

Of this species a ventral and dorsal valve occur in the collection. General form rounded subquadrangular. Ventral valve strongly convex, with the greatest height at the umbo, from which the beak arches over a high backward-inclining area. Dorsal valve much like the ventral in form except that it is less convex and less elevated at the area.

Surface of both valves with numerous radiating ribs that have an angular summit and an angular depression between them. The ribs increase in number toward the front by interpolation. The ventral valve has a length of 7 mm.; width, 8 mm. The dorsal valve is a little shorter than the ventral.

Observations.—This shell is not unlike *Eoorthis indianola* in form and surface characters. It differs in being more convex and in the absence of a sinus or median fold on either valve.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**C64**) Upper limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 42 (first list of fossils), and fig. 10 (bed 20), p. 38], 2.7 miles (4.3 km.) southwest of Yenchuang, Sintai district, Shantung, China.

EOORTHIS HASTINGSENSIS (Walcott).

Plate XCIV, figures 3, 3a–c.

Orthis (*Plectorthis*) *hastingsensis* WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 263. (Described and discussed as below as a new species.)

Shell transversely subelliptical. Surface with numerous strong, rounded, radiating ribs increasing in number by interpolation; the ribs appear to be broader and with narrower interspaces on the ventral valve; concentric ridges and fine striæ of growth are a marked feature of the surface. A ventral valve 4 mm. in length has a width of 6 mm.; a dorsal valve 6 mm. long is 10 mm. in width.

Ventral valve strongly convex, most elevated on the umbo, and without mesial fold; apex incurved slightly over the delthyrium; area well defined, and divided midway by a large delthyrium; it is inclined but little from the vertical.

Dorsal valve slightly convex in young shells, and becoming more so as they increase in size; area low and inclined backward over the hinge line.

Observations.—This species is unlike other described forms in the character of its ribs, with the exception of *Eoorthis johannensis*, which it resembles very closely. Matthew [1892, p. 49] describes the latter species as having a very thin shell, and it is found in the Upper Cambrian at St. John. No interior features have been seen. Matthew [1897b, p. 170] mentions having found fragments of *Protorthis* or *Orthis* in the phosphate nodules at Hastings Cove, too imperfect for description.

The species derives its specific name from its occurrence at Hastings Cove.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**2 1 and 2m**)[a] *Limestone and superjacent shale at the base of the Paradoxides zone* [*Matthew, 1895a, p. 108*], *on Hanford Brook, St. John County;* and (2s) limestone in upper part of *Paradoxides* zone, Hastings Cove [Matthew, 1898b, p. 38], on Kennebecasis Bay, 0.5 mile (0.8 km.) northeast of Torryburn, on the Intercolonial Railway northeast of St. John, St. John County; all in New Brunswick.

[a] 21 is the type locality.

Eoorthis iddingsi (Walcott).

Plate XCI, figures 3, 3a–b.

Orthis? remnicha Walcott (in part) [not N. H. Winchell], 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, pp. 451–452, Pl. LXII, figs. 1a and 1b (not Pl. LXI, figs. 3 and 3a, or Pl. LXII, figs. 1, 1c, and 1d). (Specimens now referred to *Eoorthis iddingsi* were included with *E. remnicha* when this description was written, two being figured, Pl. LXII, figs. 1a and 1b. The specimens represented by these two figures are redrawn in this monograph, Pl. XCII, figs. 3 and 3a, respectively. The specimens represented by Pl. LXI, figs. 3 and 3a, and Pl. LXII, figs. 1, 1c, and 1d belong with *Eoorthis remnicha*.)

Orthis (*Plectorthis*) *iddingsi* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 264. (Characterized as below as a new species.)

General form and convexity much like that of some varieties of *Eoorthis indianola*. Its surface characters also approach those of the more regularly ribbed shells of the latter species. The principal difference between the two species is the less convexity, lower umbo, and lower area of *E. iddingsi*. The interior of the ventral valve shows a short, well-defined umbonal cavity with a strong vascular sinus on each side of it that extends well forward into the valve.

The specific name is given in honor of Prof. Joseph P. Iddings.

Formation and locality.—**Upper Cambrian:** (302c) *Shaly limestone on the south side of the Gallatin Valley, Yellowstone National Park, Wyoming;* and (302d) limestone 200 yards (183 m.) north of the southwest corner sec. 18, T. 28 N., R. 113 W., Uinta County; both in Wyoming.

(71) Limestone in Cold Creek Canyon, Burnet County, Texas.

Eoorthis indianola (Walcott).

Plate XCIV, figures 1t, 1u, 2, 2a–h.

Orthis (*Plectorthis*) *indianola* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 264–265. (Described and discussed essentially as below, as a new species.)

Pectorthis indianola (Walcott), Grabau and Shimer, 1907, North American Index Fossils, vol. 1, pp. 251–252. (Described.)

Shell small, transverse, with the cardinal extremities rounded, angular, and in some specimens almost alate. Valves moderately convex, the ventral nearly twice as much so as the dorsal; the length of the hinge line varies from slightly less than the greatest width of the shell to one-fifth greater than the width of the shell across the center, in shells with extended cardinal extremities.

The ventral valve may or may not have a mesial depression. In some examples the depression is broad and rounded, and in others it is shallow with stronger ribs at each margin; umbo somewhat elevated, and curving over toward the hinge line, beyond which it projects, terminating in a small, incurved beak; dorsal valve considerably less convex than the ventral; beak small and projecting slightly over the hinge line. The median sinus in the dorsal valve varies from a broad, shallow depression to a narrow, rather deep, furrow, that gives a bilobed appearance to the valve (Pl. XCIV, fig. 2f).

The strength and arrangement of the strong and minor radiating elevated ribs and striæ are quite variable. On some shells the ribs or striæ are very fine, of nearly equal size, and separated by grooves of about the same width (Pl. XCIV, figs. 2f, 2g, and 2h). In other examples every third or more widely separated rib is stronger and elevated above a more or less broad interspace, marked by fine ribs or costæ (Pl. XCIV, fig. 2). A few of the variations in surface are illustrated.

Almost nothing is known of the interior of the valves. Below the umbo in a few specimens there is a well-marked pseudospondylium that is much like that of *E. remnicha*. The area of the ventral valve is inclined at an angle of about 65° to the plane of the margin of the valve; it is rather low and broken midway by a strong delthyrium. The area of the dorsal valve is low and inclined well out over the hinge line.

Observations.—Eoorthis indianola is almost as variable in its form and surface markings as *E. wichitaensis*, with which it is associated at a number of localities. It differs from the latter in its bilobed dorsal valve, more strongly incurved umbo and apex of the ventral valve, and

the general appearance of convexity and rotundity of the ventral valve. This may be seen by comparing the shells marked W = *E. wichitaensis* with those marked X = *E. indianola* in Plate XCIV, figure 1u, which represents a fragment of limestone in which the two species are associated. When the specimens of the two species are imperfect or the young shells of *E. wichitaensis* occur in association with the shells of *E. indianola* it is difficult to determine positively to which species they belong.

The specific name is derived from Indian Territory (now Oklahoma), in which the type specimen was found.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**369**) Sandstones at the base of the Elvins formation, in the eastern limits of the town of Flat River, St. Francois County; and (**369b**) limestone near Potosi, Washington County; both in Missouri.

(**9t**) About 170 feet (52 m.) above the porphyry contact in the limestones of the Reagan sandstone; and (**9u**) about 195 feet (59.4 m.) above the porphyry contact in the limestones of the Reagan sandstone; both in the SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W., about 15 miles (24.2 km.) northwest of Fort Sill, Comanche County, Oklahoma.

(**9w**) About 100 feet (30.5 m.) below the Arbuckle limestone, in the limestones of the Reagan sandstone, SW. ¼ sec. 17, T. 4 N., R. 12 W., about 11 miles (17.6 km.) northwest of Fort Sill, Comanche County, Oklahoma.

(**12k**) *Limestones of the Reagan sandstone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 225 feet (69 m.) above the porphyry contact and 55 feet (17 m.) below the Arbuckle limestone), on the west side of Honey Creek, near the southeast corner of sec. 35, T. 1 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County;* (**12n**) limestones of the Reagan sandstone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 240 feet (73 m.) above the porphyry contact and 40 feet (12 m.) below the Arbuckle limestone), NW. ¼ sec. 1, T. 2 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County; and (**12p**) about 225 feet (69 m.) above the igneous rocks in the limestones of the Reagan sandstone, at the northwest extremity of the Arbuckle Mountains, about 4 miles (6.4 km.) east of Homer, Carter County; all in Oklahoma.

(**14b**) Limestone on Cold Creek at north end of gorge opposite the north end of Sponge Mountain, 2 miles (3.2 km.) south of the San Saba County line, in Llano County; and (**71**) limestone in Cold Creek Canyon, Burnet County; all in Texas.

Specimens that are doubtfully referred to this species occur at the following locality:

Upper Cambrian: (**68**) Limestone on Packsaddle Mountain, Llano County, Texas.

EOORTHIS JOHANNENSIS (Matthew).

Plate XCVII, figures 10, 10a.

Orthisina(?) johannensis MATTHEW, 1892, Trans. Roy. Soc. Canada for 1891, 1st ser., vol. 9, sec. 4, No. 5, pp. 49–50, Pl. XII, figs. 13a–c. (Described and discussed as a new species; see below for copy. The specimens represented by figs. 13a–c are redrawn in this monograph, Pl. XCVII, figs. 10 and 10a, respectively.)

Orthis (Plectorthis) johannensis (Matthew), WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 265–266. (Original description copied and species discussed as below.)

The original description by Matthew follows:

Shell subquadrate, doubly convex, rather flat, very thin.

Dorsal valve depressed at the sides and front, and having a broad, shallow median sinus. The valve is about one-quarter wider than long, and the hinge line is nearly as long as the length of the shell. Umbo slightly elevated, hinge plate weak and thin.

Ventral valve depressed at the sides, and having a few median ridges running from the umbo to the front of the shell. This valve is somewhat geniculated at two-fifths of its length from the umbo, and from the bend faintly raised ridges diverge to the anterior angles of the shell; behind the geniculation the surface of the shell is marked by faint undulations similar to those of *Strophomena rhomboidalis*.

The umbo is not prominent, but the back of the valve is regularly curved and the area rather low.

Closely set striæ radiating from the umbo and faint concentric striæ mark the shell.

Length of the ventral valve, 9 mm.; width, 10 mm. Length of dorsal, 8 mm.; width, 10 mm.

This species has a low umbo for an *Orthisina*, and in its form recalls the genus *Strophomena*, as also do the concentric undulations that are found on the back of the ventral valve. The dorsal valve, however, is convex, and the area of this and the ventral valve too high for a *Strophomena*. It does not appear to agree with any described species of *Orthisina*. It resembles *O. orientalis* White somewhat in form, but is not so long nor so wide at the hinge. From *O. pepina* Hall it differs in its lower umbo and area, shorter hinge, and smoother surface. It approaches more closely to the form from the Potsdam sandstone of the West, figured by Hall [1863, Pl. VI, fig. 22], but not named, except as "*Strophomena* or *Strophodonta*."

Doctor Matthew very kindly sent me the types of this species. There is little that can be added to his very complete description, but I had two enlarged drawings made to illustrate

the character of the surface more fully than the illustrations given by Matthew [1892, Pl. XII, figs. 13a–c]. As far as known, the characters of the shell are those of the group of species referred to *Eoorthis*.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**308b** [Matthew, 1892, p. 49]) Limestone lentiles in black shales of Division C3a of Matthew's section, Germaine Street, St. John, St. John County, New Brunswick.

EOORTHIS KAYSERI (Walcott).

Plate XCVII, figures 6, 6a–b.

Orthis (*Plectorthis*) *kayseri* WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 266. (Characterized as below as a new species.)

This is a larger shell than *Eoorthis linnarssoni* (Kayser), with which it is associated. Its surface is marked by numerous fine radiating striæ, four or five in a distance of 1 millimeter, and the inner layers of the shell appear to be minutely punctate. The ventral valve is more convex than the dorsal, the latter being nearly flat in young shells. Nothing is known of the interior, except one cast of the pseudospondylium of the dorsal valve, which is larger in proportion than that of *E. linnarssoni*.

The largest ventral valve has a length of 14 mm.; width, 20 mm.

This species belongs in the group of *Eoorthis* represented by *E. desmopleura* (Meek) and *E. linnarssoni* (Kayser).

The specific name was given in honor of Dr. E. Kayser.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**C64**) *Upper limestone member of the Kiulung group* [*Blackwelder, 1907a, pp. 37 and 42* (*first list of fossils*), *and fig. 10* (*bed 20*), *p. 38*], *2.7 miles* (*4.3 km.*) *southwest of Yenchuang, Sintai district, Shantung;* (**C68**) upper part of the Chaumitien limestone [Blackwelder, 1907a, p. 36 (part of third list of fossils)], at Chaumitien, Changhia district, Shantung; and (**C74**) a dense blue dolomitic limestone at the top of the Kichou limestones [Willis and Blackwelder, 1907, pp. 139 and 145 (5th list of fossils)], 4 miles (6.4 km.) east of Fanglanchon, Shansi; all in China.

EOORTHIS KICHOUENSIS (Walcott).

Plate LXXXIX, figure 5.

Orthis (*Plectorthis*) *kichouensis* WALCOTT, 1906, Proc. U. S. Nat. Mus., vol. 30, p. 570. (Described as below as a new species.)

This species is represented by one specimen of the dorsal valve. The outline of the shell is transversely rounded subquadrilateral; length, 9 mm.; width, 13 mm.; the highest point above the plane of the margin is about 3 mm.; the shallow median sinus, which begins at the umbo above the hinge line, gradually widens toward the front margin; the umbo curves over beyond the hinge line and then under to the beak, which apparently is at or a little over the upper edge of a very narrow area.

Surface marked by numerous radiating, rounded ribs, with narrow interspaces, 7 ribs in a distance of 45 mm.; a few bifurcations of the ribs occur at irregular intervals between the apex and the margins. There are no traces of concentric striæ; if on the shell originally, they have been removed by the wearing off of the outer surface.

Observations.—This species is distinguished from all other species by the strong, incurved umbo and rounded ribs with narrow interspaces.

The specific name was derived from the Kichou formation, in which the species occurs.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**C75**) Limestone near the base of Kichou formation [Willis and Blackwelder, 1907, p. 143], 4.5 miles (7.2 km.) south of Wutaihien, Shansi, China.

EOORTHIS LINNARSSONI (Kayser).

Plate XCVII, figures 5 and 5a.

Orthis linnarssoni KAYSER, 1883, China, by Richthofen, vol. 4, p. 34, Pl. III, fig. 1. (Described and discussed in German as a new species, see p. 783 for translation. Fig. 1 is reproduced in this monograph, Pl. XCVII, fig. 5a.)

Orthis (*Plectorthis*) *linnarssoni* (Kayser), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 266. (Original description copied and species discussed as below.)

The original description by Kayser follows:

Shell semielliptical in outline, broader than long, with hinge edge straight, corresponding to the greatest breadth of the shell. Large (ventral) valve moderately convex. Small (dorsal) valve slightly arched, with a sinus which develops at the umbo and grows quite broad and deep toward the edge. Umbo of ventral valve small, area very low. Surface of shell covered with rather sharp ribs, exceedingly variable in strength, separated by narrow furrows. By reason of repeated splitting, which begins close to the umbo, the ribs appear more like bundles of ribs. On the matrix these bundles appear as broad, obtuse-angled folds, which, owing to repeated marginal splitting in even a higher degree than on the shell itself, appear as bundles of ribs of very unlike strength. When the surface is well preserved, a delicate concentric growth striation is perceptible.

Kayser [1883, p. 35] compares this shell with *"Orthis hicksi"* Salter and *"O. exporrecta"* Linnarsson, on account of the surface characters. It does not appear to be very closely related to either species, but it is in many respects allied to *Eoorthis desmopleura* (Meek) and *E. wichitaensis* (Walcott).

The specific name is given in honor of Dr. J. G. O. Linnarsson.

Formation and locality.—**Upper Cambrian:** (**C64**) Upper limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 42 (first list of fossils), and fig. 10 (bed 20), p. 38], 2.7 miles (4.3 km.) southwest of Yenchuang, Sintai district; and (**C67**) stream gravels used in making the railroad grade 0.33 mile (0.5 km.) west of the west city gate at Tsinan; both in Shantung, China.

(**332a**) [*Kayser, 1883, p. 34*] *Taling, Liaotung, China.*

Eoorthis newberryi Walcott.

Text figures 69A–D.

Eoorthis newberryi Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 105, Pl. X, figs. 6 and 6a. (Described and discussed as below as a new species. Figs. 6 and 6a are copied in this monograph as figs. 69B and 69D.)

Shell transversely subelliptical, with the cardinal extremities obtusely angular; valves moderately convex, with the hinge line a little shorter than the greatest width of the valves. The only ventral valve in the collection showing a mesial fold (fig. 69A) is a small exfoliated shell that is somewhat doubtfully referred to the species. Two large valves, one of which is illustrated by figure 69B, have the posterior margin extended beyond the hinge line, with a short incurved beak; a broad, shallow median sinus begins in front of the umbo and widens to nearly one-third of the width of the valve at the frontal margin. On a shell 5 mm. in length the sinus is very shallow; area unknown. The dorsal valve is almost uniformly convex and without a mesial sinus or fold; the front margin arches upward a little to provide for the extension of the margin of the ventral valve caused by its broad median sinus; beak minute and marginal; area unknown.

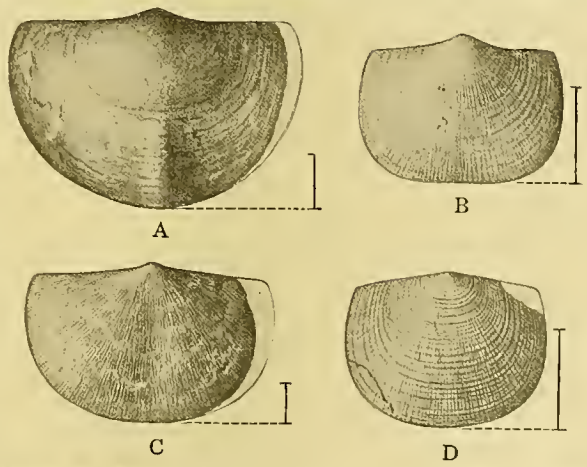

Figure 69.—*Eoorthis newberryi* Walcott. A, Partly exfoliated ventral valve (U. S. Nat. Mus. Cat. No. 52350a). B, Ventral valve, the type specimen, preserving some of the surface characters (U. S. Nat. Mus. Cat. No. 52350b). C, Small exfoliated ventral valve (U. S. Nat. Mus. Cat. No. 52350c). D, Partly exfoliated dorsal valve (U. S. Nat. Mus. Cat. No. 52350d).

The specimens represented are from Locality 54c, Upper Cambrian limestone of the St. Charles formation, in Blacksmith Fork Canyon, east of Hyrum, Cache County, Utah. Figures 69B and 69D are copied from Walcott [1908d, Pl. X, figs. 6 and 6a].

Surface marked by concentric lines and ridges of growth and small, rounded, radiating ribs, with two or three smaller ribs between each two larger ridges. The shell structure is fibrous and impunctate as far as can be determined from the material available for study. The largest ventral valve has a length of 14 mm.; width, 18 mm. A dorsal valve 15 mm. in length has a width of 18 mm.

Observations.—In form this species resembles some species of *Eoorthis remnicha* (Winchell) (Pls. XCI, XCII), but in surface characters it is quite unlike any of them.

The specific name is given in honor of Dr. J. S. Newberry.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**54c**) *About 1,100 feet (335.3 m.) above the Middle Cambrian and 120 feet (36.6 m.) below the top of the Upper Cambrian in the central part of the limestones forming 1 of the St. Charles formation* [*Walcott, 1908f, p. 192*]; and (**54d**) about 1,050 feet (320 m.) above the Middle Cambrian and 175 feet (53.3 m.) below the top of the Upper Cambrian, in the lower part of the limestones forming 1 of the St. Charles formation [Walcott, 1908f, p. 192]; both in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

EOORTHIS NEWTONENSIS (Weller).

Plate XCVII, figures 9, 9a.

Orthis newtonensis WELLER, 1903, Geol. Survey New Jersey, Rept. Paleontology, vol. 3, pp. 113–114, Pl. I, figs. 3–5. (Described and discussed as a new species.)

Orthis (*Plectorthis*) *newtonensis* (Weller), WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 267. (Described and discussed as below.)

This little shell occurs in the form of casts in a sandstone that is too coarse to preserve the details of the outer surface. The cast of the interior shows fine, simple, radiating ribs that increase by interpolation and that are coarser on the ventral than on the dorsal valve. Ventral valve slightly flattened at the front; dorsal valve with a broad mesial sinus. The shell appears to have been thin. The cast of the pseudospondylium of the ventral valve shows it to have been clearly defined; the area is low and not sharply defined from the curve of the cardinal margin; it is nearly vertical to the plane of the margin of the valve. The cast of the area beneath the umbo in the dorsal valve is more triangular and less transverse than usual; unfortunately the material is too imperfect to determine any details.

Observations.—This species is the eastern representative in the Upper Cambrian of *Eoorthis indianola* (Walcott) and *E. iddingsi* (Walcott). As far as can be determined by the material available for comparison it is closely related to those species but it is not probable that they are specifically identical.

The specific name is derived from Newton, New Jersey.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**11c**) Hardyston quartzite [Weller, 1900, pp. 10 and 12], O'Donnell and McManniman's quarry, Newton, Sussex County, New Jersey.

EOORTHIS PAGODA (Walcott).

Plate XCVII, figures 12, 12a–d.

Orthis (*Plectorthis*) *pagoda* WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 267–268. (Described and discussed as below as a new species.)

Shell transverse, subsemicircular; a ventral valve 11 mm. in length has a width of 15 mm., and a dorsal valve 8 mm. in length has a width of 13 mm.; hinge line a little shorter than the greatest width of the shell; cardinal angles vary from 75° to 111°; valves moderately convex. Cardinal area narrow in both valves and inclined backward from the hinge line. Surface marked by equidistant, narrow, low ribs, 3 in a space of 2 mm. near the front margin of a shell 10 mm. long, with fine, radiating striæ between them; the radiating ribs and striæ are crossed by fine, concentric striæ, and lines of growth.

Ventral valve with a strong, somewhat angular, median fold rising from a well-defined depression on each side of it, or it might be designated as a very strong rib rising above the general surface of the valve from a broad, median depression; the lateral slopes are gently convex. Dorsal valve with a strong, angular, median depression, beginning at the posterior margin and gradually widening to the front; the sides of the depression rise above the general surface of the valve, and form with the outer slope a well-defined low ridge on each side that extends a little forward on the front margin to fit into the depressions on each side of the median fold of the ventral valve.

The interior of a small dorsal valve has a broad, strong ridge corresponding to the depression on the exterior surface; a main vascular sinus starts on each side of the base of the median ridge and arches outward and then forward about a depressed oval space on each side of the

ridge; lateral branches extend from the main sinus toward the sides; the impressions of the anterior and posterior adductor muscle scars occur on the slopes of the median ridge and the oval depressions; somewhat obscure radiating lines mark the anterior portions of the surface.

Observations.—This shell is distinguished by its strongly marked median ridge on the ventral valve and sinus on the dorsal valve. In general form and surface markings it is not unlike *Eoorthis desmopleura* (Meek) and *E. wichitaensis* (Walcott).

The specific name is derived from Pagoda Hill, the type locality.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**C56**) *Lower part of Chaumitien limestone, at Pagoda Hill* [*Blackwelder, 1907a, p. 42 (part of last list of fossils)*], *1 mile (1.6 km.) west of Tsinan;* and (**C54**) lower part of the Chaumitien limestone [Blackwelder, 1907a, p. 42 (part of last list of fossils)], 0.66 mile (1.1 km.) west of Tsinan; both in Shantung, China.

EOORTHIS PAPIAS (Walcott).

Plate XCI, figure 4.

Orthis (Plectorthis) papias WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 268. (Characterized as below as a new species.)

This species is founded to receive a form represented by two small dorsal valves from the *Paradoxides* zone of Newfoundland. They are moderately convex, with a low area divided by a broad delthyrium; surface marked by numerous, rounded, depressed ribs, crossed by concentric striæ and ridges of growth. Length of shell, 4 mm.; width, 5 mm.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**61**) Shales near the top of No. 6 of the Manuels Brook section [Walcott, 1891b, p. 261], east side of Manuels Brook, Conception Bay, Newfoundland.

EOORTHIS PRIMORDIALIS (de Verneuil and Barrande).

Plate XCVII, figures 1, 1a–d.

Orthis primordialis DE VERNEUIL and BARRANDE, 1860, Bull. Soc. géol. France, 2d ser., vol. 17, pp. 532–533, Pl. VIII, figs. 6, 6a–d. (Described and discussed in French, as a new species; see below for translation. Figs. 6, 6a–d are reproduced in this monograph, Pl. XCVII, figs. 1, 1a–d, respectively.)

Orthis primordialis de Verneuil and Barrande, MALLADA, 1875, Bol. Com. Mapa Geológico España, tome 2, p. 31. (Mentioned in Spanish.)

The original description by de Verneuil and Barrande follows:

Shell transverse, rounded on the sides, wider than long. Hinge ridge does not extend to lateral extremities and measures hardly more than three-fourths of the total breadth of the shell. The two valves are of about the same thickness. The ventral valve[a] is provided with an area hardly higher than that of the opposite valve, but it is distinguished from it by a sinus which is almost as deep as that of the Spirifers, and which in front forms a very pronounced and more or less sharp fold. Surface ornamented with striæ, very dichotomous on the sides and almost simple in the sinus; at a distance of 5 mm. from the beak, 7 striæ are counted in a space of 5 mm.

Breadth, 16 mm.; length, 12 mm.; thickness, 7 mm.

By its deep sinus, this species is distinguished from most of its congeners and establishes a sort of passage between the genera *Orthis* and *Spirifer;* however, the pronounced area observed on each of the two valves is a characteristic which links it with the former rather than with the latter genus. *Orthis* species provided with sinuses are rather rare; the principal ones are *O. sinuata* Hall and *O. striatula* Schl., which for that matter have no other analogy with our species. It might perhaps be assimilated to *O. lynx*, which also has two areas equally developed, but the latter species will always be recognized by the small number and nondichotomous nature of its folds.

Observations.—This shell is more strongly developed in the sinus of the ventral valve and the fold of the dorsal valve than any other species of Cambrian *Eoorthis*, with the possible exception of *E. indianola* (Walcott) of the Middle and Upper Cambrian of the Wichita Mountains of the United States. The latter has a higher area on the ventral valve and the sinus is often shallow, while the fold is usually absent.

FORMATION AND LOCALITY.—**Middle Cambrian:** (**350** [de Verneuil and Barrande, 1860, p. 538]) Red limestone of the *Paradoxides* zone, near Adrados, north of Sabero and Boñar, Cantabrian Mountains, Province of Leon, northwestern Spain.

[a] Following here the example of Owen and Davidson, we call ventral valve the larger of the two, the one which is provided with a large area, and which formerly was called dorsal valve.

Eoorthis remnicha (N. H. Winchell).

Text figure 7, page 299; Plate XCI, figures 1, 1a–s; Plate XCII, figures 2, 2a–d, 3, 3a–e.

Orthis remnicha N. H. Winchell, 1886, Fourteenth Ann. Rept. Geol. and Nat. Hist. Survey Minnesota, pp. 317–318, Pl. II, fig. 7. (Described and discussed as a new species.)

Orthis? remnicha Winchell, Walcott (in part), 1899, Mon. U. S. Geol. Survey, vol. 32, pt. 2, pp. 451–452, Pl. LXI, figs. 3 and 3a; Pl. LXII, figs. 1, 1c–d (not figs. 1a and 1b). (Described and discussed essentially as below. The specimens represented by Pl. LXI, figs. 3 and 3a, and Pl. LXII, figs. 1, 1c, and 1d, are redrawn in this monograph, Pl. XCII, figs. 2b, 2a, 2, 2d, and 2c, respectively. The specimens represented by Pl. LXII, figs. 1a and 1b, are now referred to *Eoorthis iddingsi*.)

Orthis (*Plectorthis*) *remnicha* (Winchell), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 268–269. (Described and discussed essentially as below.)

Plectorthis remnicha (Winchell), Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 252. (Described.)

Shell of medium size, usually slightly transverse, with an oblong, oval outline for the ventral valve, and a subquadrate to semicircular outline for the dorsal valve. Valves moderately convex, with an almost straight hinge line that varies in length from nearly the greatest width of the shell to two-thirds the greatest width; cardinal angles varying from 90° or less in the extreme forms, with extremities somewhat angular, to the other extreme, where they are very obtuse and have the appearance of being almost rounded, their angle being not less than 120°. Cardinal area narrow but well developed on each valve, and divided by a rather large delthyrium.

The ventral valve has in some specimens a shallow mesial depression, and in some examples it is flattened toward the cardinal angles; beak small and curving down toward the hinge line, beyond which it projects slightly. Dorsal valve slightly less convex than the ventral; beak small, scarcely projecting beyond the hinge line.

Surface marked by bifurcating, radiating costæ, that vary in number on shells of similar size from 16 in the space of 5 mm. to 3 in the same space; this variation is shown in the specimens from Texas, Wisconsin, and Wyoming. As the shell grew the ribs increased in number by interpolation and by bifurcation from the sides of the larger ribs. In well-preserved specimens very fine, radiating, raised striæ occur both on the costæ and on the intervening depressions (Pl. XCII, fig. 2c). These are shown on the casts of the shells from the "St. Croix sandstone of Winfield, Wisconsin, and on the larger shells from the limestones of Oklahoma and the Yellowstone National Park. A very perfectly preserved fragment of the outer shell covering the umbo and apex of a ventral valve from the limestone of the Reagan sandstone, Oklahoma, has sharp ribs of varying size extending to the worn apex; the ribs are crossed by very fine, threadlike striæ and a few stronger lines of growth.

The interior of the ventral valve shows a slightly raised tripartite pseudospondylium beneath the umbo, which is the only trace of interior markings of this valve observed. The interior of the dorsal valve has a slightly elevated area upon which occurs a narrow, short median septum; the crural plates are also well shown. In casts of the interior of shells from the "St. Croix sandstone" of Wisconsin, the dental lamellæ of the ventral valve are finely shown, and in the dorsal valve the median septum and crural plates.

Observations.—The shell is one of the most variable that occurs in the Cambrian fauna. Its range of variation in all of the widely separated localities in which it occurs is such that one would scarcely hesitate, if in possession only of the extremes, to identify two well-marked species. The variation is not only in the radiating costæ, but also in the general form of the shell. This variation is expressed in three varieties that receive names, and others might be designated if more minute variations were given consideration.

There does not appear to be any system governing the number or size of the radiating ribs; the variation on adult shells is equally great with that between young shells 3 to 4 mm. long and adults. A series from Winfield, Wisconsin, representing *Eoorthis remnicha winfieldensis*, is uniform in radial ribs and form from young shells 3 mm. long to the largest adults 23 mm. long, and there are also shells that serve to unite the numerously and uniformly ribbed specimens with the more variable *Eoorthis remnicha*.

Some of the shells referred to *E. remnicha* (Pl. XCI, figs. 1, 1a, and 1e) suggest *Platystrophia* in their form and radiating ribs.

FORMATION AND LOCALITY.—**Upper Cambrian:** (80a) "St. Croix sandstone," 4 miles (6.4 km.) north of Reedsburg, Sauk County; (328q) "St. Croix sandstone" in quarry at Ableman, Sauk County; and (97a) "St. Croix sandstone," near Winfield, Jefferson County; all in Wisconsin.

(86a) "*St. Croix sandstone*," *near Red Wing, Goodhue County, Minnesota.*[a]

(153a and 154) Limestone on west side of Dry Creek, near the mouth of Pass Creek, about 5 miles (8 km.) north of Hillsdale, Threeforks quadrangle (U. S. Geol. Survey), Gallatin County; (302n) limestone on the south side of the Gallatin Valley, Gallatin County; and (4r) just above the Middle Cambrian in the limestones of the Gallatin formation of Peale [1893, Pl. IV], on ridge 8 miles (12.8 km.) east of Yellowstone River, and 3 miles (4.8 km.) north-northeast of Mount Delano, Livingston quadrangle (U. S. Geol. Survey), Park County; both in Montana.

(168) Limestone on north side of Tepee Creek, beside the road from Sheridan to Dome Lake, Bighorn Mountains, Sheridan County, Wyoming.

(12k) Limestones of the Reagan sandstone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 225 feet (69 m.) above the porphyry contact and 55 feet (17 m.) below the Arbuckle limestone) on the west side of Honey Creek, near the southeast corner of sec. 35, T. 1 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County; (12n) limestones of the Reagan sandstone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 240 feet (73 m.) above the porphyry contact and 40 feet (12 m.) below the Arbuckle limestone), NW. ¼ sec. 1, T. 2 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County; and (12p) about 225 feet (69 m.) above the igneous rocks in the limestones of the Reagan sandstone, at the northwest extremity of the Arbuckle Mountains, about 4 miles (6.4 km.) east of Homer, Carter County; all in Oklahoma.

Middle Cambrian: (302b) Limestone near Crowfoot Ridge, Gallatin quadrangle (U. S. Geol. Survey), Yellowstone National Park, Wyoming.

Specimens that are somewhat doubtfully referred to this species occur at the following locality:

Middle Cambrian: (3x) About 2,200 feet (670.6 m.) above the Lower Cambrian and 2,200 feet (670.6 m.) below the Upper Cambrian in the limestone forming ld of the Marjum limestone [Walcott, 1908f, p. 180], 2.5 miles (4 km.) east of Antelope Springs, in ridge east of Wheeler Amphitheater [Walcott, 1908f, Pls. XIII and XV], House Range, Millard County, Utah.

EOORTHIS REMNICHA SULCATA (Walcott).

Plate XCII, figures 1, 1a–c.

Orthis (*Plectorthis*) *remnicha sulcata* WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 269. (Characterized somewhat as below as a new variety.)

This variety is founded on the strongly sulcate dorsal valve. The ventral valve shows only a slight flattening of the median portion. *Finkelnburgia osceola* (Pl. XCIII) has a mesial fold on the dorsal valve, but it is not so sharp.

FORMATION AND LOCALITY.—**Upper Cambrian:** (80a) "*St. Croix sandstone*," *4 miles (6.4 km.) north of Reedsburg, Sauk County;* and (97a) "St. Croix sandstone" near Winfield, Jefferson County; both in Wisconsin.

(339d) "St. Croix sandstone" at Taylors Falls, Chisago County; and (97x) "St. Croix sandstone" at Reads Landing, foot of Lake Pepin, Wabasha County; both in Minnesota.

EOORTHIS REMNICHA TEXANA (Walcott).

Plate XCII, figures 4, 4a–g.

Orthis (*Plectorthis*) *remnicha texana* WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 270. (Characterized as below as a new variety.)

The rounded, subquadrate form and the arrangement of the radiating costæ serve to differentiate this variety. The costæ vary considerably on different shells, but the tendency of the larger number is toward the surface represented by Plate XCII, figures 4c–g. Fine radiating striæ, similar to those represented by Plate XCII, figure 2c, of *Eoorthis remnicha* occur on the ribs and interspaces.

FORMATION AND LOCALITY.—**Upper Cambrian:** (12m) Arbuckle limestone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 30 feet (9.1 m.) above the Reagan sandstone), NE. ¼ sec. 2, T. 2 S., R. 1 E.; and (12n) limestones of the Reagan sandstone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 240 feet

[a] N. H. Winchell [1886, p. 317] gives the type locality as "St. Croix sandstone" in sewer excavation at the corner of Brush and Main streets, Red Wing, Minnesota.

(73 m.) above the porphyry contact and 40 feet (12 m.) below the Arbuckle limestone), NW. ¼ sec. 1, T. 2 S., R. 1 E.; both in the Ardmore quadrangle (U. S. Geol. Survey), Carter County, Oklahoma.

(153a) Limestone in ravine on west side of Dry Creek, near the mouth of Pass Creek, about 5 miles (8.1 km.) north of Hillsdale, Threeforks quadrangle (U. S. Geol. Survey), Gallatin County, Montana.

(14b) Limestone on Cold Creek at north end of gorge opposite the north end of Sponge Mountain, 2 miles (3.2 km.) south of the San Saba County line, in Llano County; (68) interbedded sandstone and limestone, Packsaddle Mountain, Llano County; and (71) *limestone in Cold Creek Canyon, Burnet County;* all in Texas.

Specimens that are somewhat doubtfully referred to this variety occur at the following localities:

Upper Cambrian: (11d) Arenaceous limestone about 2 miles (3.2 km.) north of Montana, in sec. 22, T. 35 N., R. 1 E., Iron County; and (111) arenaceous limestone of the Elvins formation, 50 feet (15.2 m.) above the "Edgewise beds," St. Francois County; both in Missouri.

Eoorthis remnicha winfieldensis (Walcott).

Plate XCI, figures 2, 2a–e.

Orthis (Plectorthis) remnicha winfieldensis Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 270. (Characterized as below as a new variety.)

This variety is characterized by having finer and more uniform costæ than any of the shells referred to *Eoorthis remnicha* (N. H. Winchell). The costæ increase by interpolation rather than bifurcation in the true sense of the word. The shorter costæ begin as very narrow, sharp ridges, merging into the sides of the larger costæ below the summit of the latter, or they may arise entirely on the interspaces between the costæ. The pseudospondylium is less strongly developed than in *E. remnicha.* The young shells are usually narrower at the hinge line than the adult; but this feature is sometimes present in large shells (Pl. XCI, fig. 2c).

The varietal name is derived from Winfield, Wisconsin.

Formation and locality.—**Upper Cambrian:** (97a) "*St. Croix sandstone,*" *near Winfield, Jefferson County;* and (99a) "St. Croix sandstone" near Pilot Knob, Adams County; both in Wisconsin.

A specimen which is somewhat doubtfully referred to this variety occurs in the following locality:

Upper Cambrian: (83) "St. Croix sandstone" at Trempealeau, Trempealeau County, Wisconsin.

Eoorthis saltensis (Kayser).

Plate XCVII, figure 11.

Orthis saltensis Kayser, 1876, Beiträge zur Geologie und Paleontologie der argentinischen Republik, vol. 2, Paleontologischen Theil; Abth. 1, p. 8, Pl. I, figs. 15, 16. (Described and discussed in German as a new species; see below for translation. Figs. 15 and 16 are reproduced in this monograph, Pl. XCVII, figs. 11′ and 11, respectively.)

Orthis saltensis? Kayser, 1897, Zeitschr. Deutsch. geol. Gesell. for 1897, Bd. 49, Heft 2, No. 2, p. 280. (Mentioned in German from new localities.)

Orthis (Plectorthis) saltensis (Kayser), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 271. (Characterized.)

The original description by Kayser follows:

Shell nearly circular in outline, with straight hinge edge, which is about equal to three-fourths of the greatest breadth of the shell, measured approximately across the middle. Ventral valve moderately and uniformly arched, with a faint keel rising in the middle. Beak short, slightly curved. Dorsal valve slightly arched, with a median depression which is flat but becomes rather broad, starting at the umbo. The surface of both valves is covered with fine but plainly marked ribs, united into bundles, the lateral ones bending somewhat outward.

In the sandstones in the province of Salta this species fills whole beds. At the town of Salta it occurs alone. At the Nevado de Castillo it is accompanied by *Lingula.* At both localities it occurs as impressions and casts, and as white, well-preserved shell, peeling off in flakes. Finally it also occurs, associated with trilobites, *Hyolithes,* and other *Orthis* species, at Tilcuya in the province of Jujuy, but there it is without calcareous shell. I know only one primordial *Orthis* with which this fine species might be compared, namely *Orthis menapiæ* Hicks [cf. Davidson, 1869, Pl. XXXIII, figs. 8–12], from the English Arenig group. In this, however, the ribs show less tendency to arrange themselves in bundles, the sinus is narrower, and the ventral valve is much more strongly keeled.

Kayser's description and figures [1876, p. 8, Pl. I, figs. 15–16] lead me to refer this species to the genus *Eoorthis.* The general form of the valves, the casts of the interior of the ventral

valve with the strong umbonal cavity, and the radiating ribs increasing in number by interpolation, appear to sustain the reference.

The species derives its name from its occurrence near Salta.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**389** [Kayser, 1876, p. 8]) *Sandstone at Salta, Province of Salta;* (**389a** [Kayser, 1876, p. 8]) sandstone at Nevado de Castillo, Province of Salta; (**389d** [Kayser, 1897, p. 280]) at Iruya, Province of Salta; (**389c** [Kayser, 1897, p. 280]) in conglomeratic sandstone at Ojo de Agua, Province of Santiago del Est; and (**389b** [Kayser, 1876, p. 8]) sandstone at Tilcuya, Province of Jujuy; all in Argentina, South America.

Kayser [1876, p. 9, Pl. I, fig. 13] also describes and illustrates the dorsal valve of a shell that he refers to *Orthis* sp. It suggests *Orusia lenticularis*.

EOORTHIS TATEI (Etheridge).

Plate XCVII, figures 15 and 15a.

Orthis (?)tatei ETHERIDGE, JR., 1905, Trans. Roy. Soc. South Australia, vol. 29, p. 249, Pl. XXV, figs. 7 and 8. (Described as below, and discussed as a new species. The specimens represented by figs. 7 and 8 are redrawn in this monograph, Pl. XCVII, figs. 15 and 15a, respectively.)

The original description by Etheridge follows:

Pedicle valve, dorsal margin comparatively straight; ventral and lateral margins rounded, the former nonmarginate; umbo small, depressed; surface in the median line moderately convex, the wings rather flattened; sculpture consisting of numerous, thick, sometimes bifurcating radiating costæ, which die out, or are only faintly perceptible on the wings or toward the lateral margins of the valves, the surface on these portions being also crossed by very fine concentric lines; by the prominence of two or three costæ on each side of the middle, a flattened space, taking the place of a sulcus, is marked off.

This species appears to belong to the group of *Eoorthis* represented by *E. remnicha* (N. H. Winchell).

The specific name is given in honor of Mr. Ralph Tate.

FORMATION AND LOCALITY.—**Middle? Cambrian:** (**315b** [Etheridge, 1905, p. 249]) Limestone at Wirrialpa, Flinders Range, South Australia.

EOORTHIS THYONE Walcott.

Text figures 70A–C.

Nisusia rara WALCOTT (in part), 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 97, Pl. IX, fig. 13 (not fig. 13a, which represents a specimen of *Nisusia rara*). (No text reference. Fig. 13, which is reproduced in this monograph as fig. 70A, was inserted on Pl. IX of this reference by mistake. All of the figures representing the two species (*Nisusia rara* and *Eoorthis thyone*) happened to be grouped on the same preliminary plate and when two figures were chosen to represent *Nisusia rara* in the paper referred to, one of the figures representing *Eoorthis thyone* was accidentally included.)

Eoorthis thyone WALCOTT, 1908, idem, pp. 105–106, Pl. X, figs. 7 and 7a. (Described and discussed as below as a new species. Figs. 7 and 7a are copied in this monograph as figs. 70B and 70C, respectively.)

FIGURE 70.—*Eoorthis thyone* Walcott. A, Natural cast of a ventral valve, the type specimen, showing cast of a pseudospondylium (U. S. Nat. Mus. Cat. No. 52378). B, Natural cast of a dorsal valve (U. S. Nat. Mus. Cat. No. 52377a). C, Cast of interior of dorsal valve (U. S. Nat. Mus. Cat. No. 52377b).

The specimens represented are from Middle Cambrian Marjum limestone, 2.5 miles (4 km.) east of Antelope Springs, in the ridge east of Wheeler Amphitheater, House Range, Millard County, Utah (fig. 70A from Locality **3x**, and figs. 70B and 70C from Locality **11q**). Figure 70A was published [Walcott, 1908d, Pl. IX, fig. 13] as representing the ventral valve of *Nisusia rara* and was given Cat. No. 52295a. As explained in the note under the first reference in the synonymy this was a mistake. Figures 70B and 70C are copied from Walcott [1908d, Pl. X, figs. 7 and 7a, respectively].

In outline and size this species resembles *Eoorthis wichitaensis* (Walcott) (Pl. XCIV, figs. 1, 1a–n), but in its sharp, uniform, radiating ribs it differs from that and other species having a somewhat similar outline. The ribs radiate from the beak and increase in number by interpolation of new ribs at irregular distances from the beak. Nothing is known of the area of either valve. A cast of the interior of a dorsal valve shows rather large muscle scars.

A large ventral valve has a length of 8 mm.; width, 9 mm.; substance of shell unknown.

Observations.—This species was at first compared with *Nisusia* (*Jamesella*) *nautes* (Walcott) (Pl. XCIII, figs. 6, 6a–b), but the surface ribs are more regular and less numerous. It also occurs 1,800 feet higher in the stratigraphic section than *N.* (*J.*) *nautes.*

Formation and locality.—**Middle Cambrian:** (3x) *About 2,200 feet (670.6 m.) above the Lower Cambrian and 2,200 feet (670.6 m.) below the Upper Cambrian, in the limestones forming 1d of the Marjum limestone* [*Walcott, 1908f, p. 180*]; and (11q) about 2,350 feet (716.3 m.) above the Lower Cambrian, and 2,050 feet (624.8 m.) below the Upper Cambrian, in the limestones forming 1c of the Marjum limestone [Walcott, 1908f, p. 180]; both 2.5 miles (4 km.) east of Antelope Springs, in ridge east of Wheeler Amphitheater [Walcott, 1908f, Pls. XIII and XV], House Range, Millard County, Utah.

Eoorthis tullbergi (Walcott).

Plate XCV, figure 3.

Orthis (*Plectorthis*) *tullbergi* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 271. (Characterized as a new species.)
Orthis (*Plectorthis*) *tullbergi* Walcott, Moberg and Segerberg, 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), p. 69, Pl. II, fig. 3. (Characterized in Swedish. Fig. 3, in common with the remaining figures on Pl. II of Moberg and Segerberg's paper, was copied from a preliminary photograph of Pl. XCV of this monograph.)

The transverse outline and simple strong ribs of *Eoorthis tullbergi* serve to distinguish it from *E. christianiæ* (Kjerulf) and *E. daunus* (Walcott).

Moberg and Segerberg [1906, pp. 69–70] are inclined to consider this form as identical with *Eoorthis christianiæ.* Since reading their remarks and conclusions I have studied the material representing the two forms *Eoorthis christianiæ* and *E. tullbergi* and have decided to leave the latter as a distinct species. There may be a complete gradation of form and surface characters between the two shells, but I do not find it in the numerous specimens before me.

The specific name was given in honor of Mr. S. A. Tullberg.

Formation and locality.—**Passage beds** between the Upper Cambrian and the Ordovician: (390) Boundary stratum between the *Orthoceras* limestone and the *Ceratopyge* limestone [Moberg and Segerberg, 1906, p. 69], at Alunbruk (alum works), southern part of Oeland Island, Sweden.

Eoorthis wichitaensis (Walcott).

Plate XCIV, figures 1, 1a–o, 1u.

Orthis (*Plectorthis*) *wichitaensis* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 271–272. (Characterized essentially as below as a new species.)

In general form and outline this shell is related to *Eoorthis desmopleura* (Meek) and *E. remnicha* (Winchell). Its convexity and differences in the radial ribbing and striation separate it from the former species, and it occurs in an older geological formation. Its convexity and surface characters distinguish it from *E. remnicha.* The series of figures illustrating the species will enable the student to study all that is known to me of the species.

A considerable number of relatively smooth shells that occur in the collection are designated as the variety *læviusculus,* but it is often difficult to separate them from the more finely ribbed specimens that are typical of the species.

Formation and locality.—**Lower Ordovician:** (360a) Red siliceous limestone on west side of Trout Creek, below Bergen Park, 7 miles (11.2 km.) north-northwest of Manitou, El Paso County, Colorado.

Upper Cambrian: (12j) Lower part of Arbuckle limestone at Small Hill, 2 miles (3.2 km.) southwest of Signal Mountain, about 8 miles (12.8 km.) west of Fort Sill; and (9z) basal beds of the Arbuckle limestone, about 25 feet above the heavy-bedded limestone, near the middle of the west half of sec. 13, T. 4 N., R. 13 W., about 13 miles (20.8 km.) northwest of Fort Sill; both in Comanche County, Oklahoma.

(9q) About 10 feet (3 m.) above the porphyry contact and 90 feet (27.4 m.) below the Arbuckle limestone in limestones of the Reagan sandstone, in middle of west half of sec. 2, T. 4 N., R. 13 W.; (9u) about 195 feet (59.4 m.) above the porphyry contact in the limestones of the Reagan sandstone, in SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W.; (9s) about 85 feet (26 m.) below the Arbuckle limestone in the limestones of the Reagan sandstone, near middle of west half of sec. 13, T. 4 N., R. 13 W.; all about 15 miles (24.2 km.) northwest of Fort Sill, Comanche County, Oklahoma.

(12k) Limestones of the Reagan sandstone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 225 feet (69 m.) above the porphyry contact and 55 feet (17 m.) below the Arbuckle limestone), on the west

side of Honey Creek, near the southeast corner of sec. 35, T. 1 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County; (12n) limestones of the Reagan sandstone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 240 feet (73 m.) above the porphyry contact and 40 feet (12 m.) below the Arbuckle limestone), NW. ¼ sec. 1, T. 2 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County; and (12p) *about 225 feet (69 m.) above the igneous rocks in the limestones of the Reagan sandstone, at the northwest extremity of the Arbuckle Mountains, about 4 miles (6.4 km.) east of Homer, Carter County;* all in Oklahoma.

(14b) Limestone on Cold Creek at north end of gorge opposite the north end of Sponge Mountain, 2 miles (3.2 km.) south of the San Saba County line, in Llano County; (68) limestone on Packsaddle Mountain, Llano County; and (71) limestone in Cold Creek Canyon, Burnet County; all in Texas.

(150a) Limestone on the east side of Dry Creek, above the mouth of Pass Creek; and (153a) limestone in ravine on west side of Dry Creek, near the mouth of Pass Creek; both about 5 miles (8 km.) north of Hillsdale, Threeforks quadrangle (U. S. Geol. Survey), Gallatin County, Montana.

(151) Limestone in point overlooking Churn Canyon, on the west side of the Bridger Range, Gallatin County, Montana.

(302e) Limestone near the top of the Deadwood formation, in Middle Popo Agie Canyon, near Lander, Fremont County, Wyoming.

Middle Cambrian: (369a) Limestone in or just beneath the "Edgewise beds" near Elvins, 6 miles (9.6 km.) south of Bonneterre, St. Francois County, Missouri.

Eoorthis wichitaensis læviusculus (Walcott).

Plate XCIV, figures 1p–s.

Orthis (Plectorthis) wichitaensis læviusculus Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 272. (Characterized essentially as below as a new variety.)

A variety with small, narrow, numerous ribs is given the above name. So many gradations exist between it and the typical forms of *E. wichitaensis* (Walcott) that the figures are arranged on the plate rather to show the gradations in surface characters than to bring out this special variety.

Formation and locality.—**Upper Cambrian:** (12k) Limestones of the Reagan sandstone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 225 feet (69 m.) above the porphyry contact and 55 feet (17 m.) below the Arbuckle limestone), on the west side of Honey Creek, near the southeast corner of sec. 35, T. 1 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County; (12n) limestones of the Reagan sandstone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 240 feet (73 m.) above the porphyry contact and 40 feet (12 m.) below the Arbuckle limestone), NW. ¼ sec. 1, T. 2 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County; and (12p) *about 225 feet (69 m.) above the igneous rocks in the limestones of the Reagan sandstone, at the northwest extremity of the Arbuckle Mountains, about 4 miles (6.4 km.) east of Homer, Carter County;* all in Oklahoma.

(14b) Limestone at north end of gorge opposite the north end of Sponge Mountain, 2 miles (3.2 km.) south of the San Saba County line; and (68) limestone in Packsaddle Mountain; both in Llano County, Texas.

Eoorthis wimani (Walcott).

Plate XCV, figures 4, 4a–d.

Orthis (Plectorthis) wimani Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 272. (Discussed essentially as below as a new species.)

Orthis (Plectorthis) wimani Walcott, Moberg and Segerberg, 1906, Medd. från Lunds geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), p. 70, Pl. II, figs. 4, 4a–d; Pl. III, figs. 14, 15a–b. (Discussed in Swedish. Figs. 4, 4a–d, in common with the remaining figures on Pl. II of Moberg and Segerberg's paper, were copied from a preliminary photograph of Pl. XCV of this monograph.)

This shell is distinguished from *Eoorthis christianiæ* (Kjerulf) and *E. daunus* (Walcott) by the rounded, narrow, simple ribs and the less transverse and more rounded outline. A ventral valve discovered after the drawings were made shows a well-defined pseudospondylium, with the tripartite division as seen in *E. remnicha* (Winchell) (Pl. XCI, fig. 1c). Two strong main vascular sinuses extend forward from the lateral divisions of the umbonal cavity nearly to the front of the valve, corresponding in position to those of the dorsal valve (Pl. XCV, fig. 4a). The cast of the dorsal valve indicates the presence of rather strong crura, crural plates, dental sockets, and delthyrium.

The ventral valve is rather strongly convex, and the dorsal valve about half as much so. The average size is 6 to 7 mm. in diameter, the ventral valve being about 1.5 mm. larger

than the dorsal. The largest ventral valve in the material available for study has a length of 9 mm.

The specific name was given in honor of Dr. Carl Wiman.

FORMATION AND LOCALITY.—**Passage beds** between the Upper Cambrian and the Ordovician: (**310j**) *Ceratopyge* limestone at Borgholm, Oeland Island, Sweden.

(**8x**) Limestone at Slemmestad, about 3 miles (4.8 km.) southwest of Christiania, Norway.

Upper Cambrian: (**390b** [Moberg and Segerberg, 1906, p. 71]) Limestones of the *Shumardia* zone (zone 3) at Fogelsång, 5 miles (8 km.) east of Lund, Province of Malmöhus; and (**390c** [Moberg and Segerberg, 1906, p. 70]) *Ceratopyge* slate (Zone 3) at Wentlinge, on Oeland Island; both in Sweden.

(**323w**) *Black argillaceous shale of Division 3aβ, at Christiania, Norway.*

EOORTHIS ZENO Walcott.

Text figures 71A–B′.

Eoorthis zeno WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 106, Pl. 10, fig. 8. (Discussed as below as a new species. Fig. 8 is copied in this monograph as fig. 71A.)

In outline the ventral valve of this species is somewhat similar to that of some forms of *Eoorthis remnicha winfieldensis* (Walcott) (Pl. XCI, fig. 2d), but it differs in having finer radiating ribs and in its smaller size. It is also much smaller than *Eoorthis newberryi* Walcott, and it occurs 4,390 feet (1,338 m.) lower in the same stratigraphic section. The character of the surface is shown by text figure 71B′, and the general form by text figure 71A. I do not know of any similar form, with such regular, fine, sharp radiating ribs, from the Cambrian. The largest ventral valve in the collection has a length of 10 mm.; width, 18 mm.

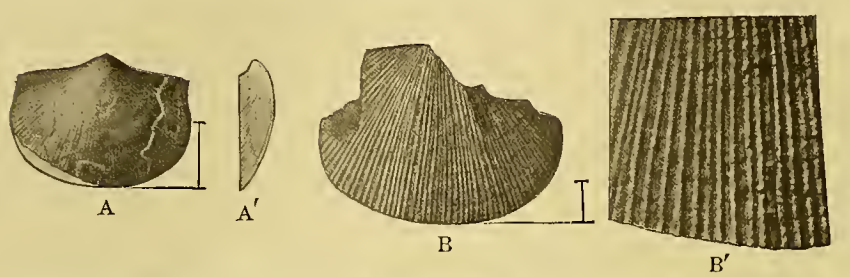

FIGURE 71.—*Eoorthis zeno* Walcott. A, A′, Exfoliated ventral valve (U. S. Nat. Mus. Cat. No. 52397a). B, Fragment of dorsal valve (U. S. Nat. Mus. Cat. No. 52397b). B′, Enlargement of portion of surface of B (× 10).

The specimens represented are from Locality **54o**, Middle Cambrian Ute limestone in Blacksmith Fork, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah. Figure 71A is copied from Walcott [1908d, Pl. X, fig. 8]. It is the type specimen.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**31c** and **54o**)[a] About 900 feet (274.3 m.) above the Brigham quartzite and 3,300 feet (1,005.8 m.) below the Upper Cambrian in the limestone forming 1b of the Ute limestone [Walcott, 1908f, p. 196], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

EOORTHIS sp. undt. a (Pompeckj).

Orthis sp., POMPECKJ, 1896, Jahrb. K.-k. geol. Reichsanstalt for 1895, Bd. 45, Hft. 3, p. 514, Pl. XV, fig. 6. (Characterized in German; see below for translation.)

Orthis (*Plectorthis*) sp. (Pompeckj), WALCOTT (in part), 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 272–273. (Original description copied.)

This species appears, from the illustration given by Pompeckj [1896b, Pl. XV, fig. 6], to belong to the genus *Eoorthis*. The material is too imperfect for specific determination. The original description is as follows:

Some impressions of dorsal valves depart from *Orthis romingeri*. The ribs are remarkably broad, flat, and separated by narrow interspaces; ribs may be observed to be split several times.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**345** [Pompeckj, 1896b, p. 514]) Greenish shale in the *Paradoxides* zone, on the Dlouhá Hora, above the brook of Sbirov, near Skrej, Bohemia, Austria-Hungary.

EOORTHIS sp. undt. b (Pompeckj).

Orthis sp. POMPECKJ, 1896, Jahrb. K.-k. geol. Reichsanstalt for 1895, Bd. 45, Hft. 3, p. 514, Pl. XV, fig. 7. (Characterized in German; see p. 793 for translation.)

Orthis (*Plectorthis*) sp. (Pompeckj), WALCOTT (in part), 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 272–273. (Original description copied.)

[a] **54o** is the type locality.

Pompeckj [1896b, p. 514] mentions another species of *Orthis* that appears to belong to the genus *Eoorthis*. The material, which is too imperfect for specific determination, was described as follows:

The impression of a dorsal valve departs from *Orthis romingeri* in its greater breadth and less distinct ribbing.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**345e** [Pompeckj, 1896b, p. 514]) Greenish shale in the *Paradoxides* zone in the gorge above Luh, near Skrej, Bohemia, Austria-Hungary.

EOORTHIS sp. undt. c (Walcott).

Plate LXXXIX, figure 7.

Orthis (*Plectorthis*) sp. undt. WALCOTT, 1906, Proc. U. S. Nat. Mus., vol. 30, p. 571. (These various shells are described and discussed essentially as below as sp. undt. c, d, and e.)

This species is represented by a single specimen of the ventral valve. Ventral valve convex, with the apex curving gently downward from the highest point to the cardinal area, transverse; length, 2.5 mm.; width, 3 mm.; hinge line a little shorter than the greatest width; cardinal area sloping slightly forward from the hinge line.

Surface marked by about 16 strong, nearly regular, rounded, radiating ribs, that are crossed by fine, concentric striæ, lines of growth, and one strong ridge indicating interruption of growth.

Observations.—This little shell was at first placed with *Eoorthis agreste* (Walcott) (Pl. LXXXIX, fig. 6), but further study showed that its greatest convexity, elevated apex, and stronger ribs distinguished it from that species.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**C26**) Near the top of the black oolite group in the uppermost layers of the Changhia formation [Blackwelder, 1907a, p. 33 (part of the last list of fossils)]; 2 miles (3.2 km.) north-northeast of Changhia, Shantung, China.

EOORTHIS sp. undt. d (Walcott).[a]

Plate LXXXIX, figure 8.

A larger shell of the type of sp. undt. c occurs in Shensi, in the central portion of the Kichou formation. It has a length of 6.5 mm. and a width of 7.5 mm. The surface is marked by numerous radiating ribs, similar to those of the shell from Changhia, also concentric striæ and several ridges resulting from interruption of growth.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**C71**) Massive cliff-making limestones in the central portion of the Kichou formation [Willis and Blackwelder, 1907, pp. 139 and 145 (2d list of fossils)], 4 miles (6.4 km.) south-southwest of Tungyu, Shansi, China.

EOORTHIS sp. undt. e (Walcott).[a]

A third shell that appears to be a dorsal valve was found associated with Middle Cambrian trilobite fragments in limestone pebbles in river gravel. The surface is partly exfoliated, but it shows rounded, radiating ribs and concentric ridges, similar to those on the two specimens described above as sp. undt. c and sp. undt. d.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**C67**) Stream gravels used in making the railroad grade, 0.33 mile (0.5 km.) west of the west city gate, Tsinan, Shantung, China.

Genus FINKELNBURGIA Walcott.

Orthis (*Finkelnburgia*) WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 277–278. (Characterized and discussed as below as a new subgenus.)

Finkelnburgia WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 148. (Classification of genus.)

This genus is based upon two species that differ from *Eoorthis* in having thick shells and strongly marked vascular trunks in the ventral valve. The type of the genus, *Finkelnburgia finkelnburgi*, with its acuminate and sometimes alate cardinal extremities and subequally convex

[a] See synonymy for *Eoorthis* sp. undt. c.

valve, is a very strongly marked type; the second species, *F. osceola*, has obtuse cardinal extremities, and most of the examples closely resemble in form *Eoorthis remnicha* (Winchell). It is only when the specimens from the fine-grained sandstone of Trempealeau are studied that one finds the thick shell and strong interior markings that are unknown in species of the genus *Eoorthis*.

This genus is named after Mr. W. A. Finkelnburg, of Winona, Minnesota, who has been one of the most intelligent and enthusiastic collectors of Cambrian and Ordovician fossils in Minnesota in recent years.

Type.—Orthis (Finkelnburgia) finkelnburgi Walcott.

Finkelnburgia finkelnburgi (Walcott)

Plate XCIII, figures 2, 2a–e.

Orthis (Finkelnburgia) finkelnburgi Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 278–279. (Described and discussed as below as a new species.)

Shell transverse with the cardinal extremities acuminate and in some examples almost alate. On the ventral valve the hinge line slopes toward the beak at a low angle; in the dorsal valve it is nearly straight. There is considerable variation in the height and width of the shell, this feature depending upon the extension of the cardinal angles. The convexity of the valves is subequal. In some examples the ventral valve is much more elevated and convex than in others, and the same is true of the dorsal valve. A low, clearly defined mesial sinus occurs on the dorsal valve, being strongest in young shells, and there is frequently a flattening of the mesial area on the ventral valve.

The surface is marked by fine, rounded, radiating costæ, crossed by concentric lines, and, occasionally, ridges of growth. In a ventral valve 7 mm. in length, 11 mm. in width, there are two costæ in a distance of 1 millimeter.

The largest specimen of a ventral valve in the collection has a length of 10 mm. with a width of 18 mm. The average shell is less than 8 mm. in length.

The cardinal area of the ventral valve is relatively high. It extends backward over the hinge line at an angle varying from 15° to 45° from the plane of the valve. The delthyrium is of moderate width and apparently partly covered by a deltidium. The cardinal area of the dorsal valve averages about one-half the height of that of the ventral valve, although in some shells it is fully two-thirds as high. It extends backward at an angle of about 70° to the plane of the valve. It is divided midway by a strong delthyrium. None of the specimens in the collections show whether there was a chilidium present or not.

In the interior of the ventral valve the strong teeth were supported by dental plates that extend to the bottom of the valve and bound the umbonal cavity (pseudospondylium). The only traces of the vascular system are the bases of strong vascular trunks, as shown in Plate XCIII, figure 2. The positions of the diductor and adductor muscle scars are shown in figure 2. The latter appear to have been carried into a very narrow space on an elevated ridge between the deep impressions made by the main vascular trunks; in figure 2a the points of attachment of the muscles are well advanced into the valve.

In the interior of the dorsal valve a cast of the interior of the pseudocruralium appears to have a small cardinal process, or callosity, but its presence is too doubtful to state that the cardinal process is present; there are traces of a median septum shown on the central ridge toward the center of the valve. The cardinal process occurs in the anterior half of the umbonal cavity. The casts of the interior show that the crura are short and well defined, with relatively strong dental sockets beside them. The only traces of the muscle scars observed are those of the adductor, as shown in figure 2e.

Observations.—The exterior surface and size of this shell recalls *Finkelnburgia osceola* (Walcott). It differs, however, in the acuminate ventral angles and strongly convex dorsal valve. In form the elongate cardinal angles relate this species to *Otusia sandbergi* (Winchell), but in surface and interior markings it materially differs from the latter.

The specific name was given in honor of Mr. W. A. Finkelnburg.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**78** and **78s**) "St. Croix sandstone," quarry near St. Croix River in suburbs of Osceola, Polk County; (**81**) "St. Croix sandstone" 1 mile (1.6 km.) east-northeast of Devils Lake, Sauk County; (**81b**) "St. Croix sandstone" near Devils Lake, Sauk County; and (**83**, **83′**, **135b**, and **135c**)[a] *"St. Croix sandstone" near Trempealeau, Trempealeau County;* all in Wisconsin.

(**339f**) "St. Croix sandstone" near Minneiska (Miniska) on Mississippi River near the line between Wabasha and Winona counties, Minnesota.

FINKELNBURGIA OSCEOLA (Walcott).

Plate XCIII, figures 1, 1a–h.

Orthis (*Finkelnburgia*) *osceola* WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 279. (Discussed essentially as below as a new species.)

The general form of this species is similar to that of *Eoorthis remnicha* (Winchell) except that it is usually more transverse. It is a smaller shell, averaging for the ventral valve a length of 8 mm. and width of 11 mm., while *E. remnicha* averages 12 mm. in length and 14 to 16 mm. in width in the adult shell. The radiating costæ are more uniformly rounded and regular, and more numerous, except when compared with the variety *texana*. The shell of *Finkelnburgia osceola* is thick, like other forms of the genus, with a result that the vascular markings are definitely outlined. In figure 1d the vascular markings are beautifully shown; also, the large main vascular sinuses so characteristic of many species of *Billingsella*. The cardinal process and median septum are well brought out in the cast, figure 1f. Some of the dorsal valves approach quite closely to those of *E. remnicha sulcata* (Walcott).

The specific name is derived from Osceola, Wisconsin.

FORMATION AND LOCALITY.—**Upper Cambrian:** "St. Croix sandstone" at the following localities: (**78** and **78s**) Quarry near St. Croix River, in suburbs of Osceola, Polk County; (**78b**) 50 feet (15 m.) above St. Croix River, near the landing at Osceola, Polk County; (**79a**) quarry and ledge 0.5 mile (0.8 km.) southeast of the county courthouse, Menomonie, Dunn County; (**80**) 0.33 mile (1.1 km.) southwest of the railway depot, Menomonie, Dunn County; (**79b**) near Hudson, St. Croix County; (**80a**) 4 miles (6.4 km.) north of Reedsburg, Sauk County; (**83**, **83′** and **135e**)[b] *near Trempealeau, Trempealeau County;* (**85x**) near Mazomanie, Dane County; and (**328i**) 0.33 mile (1.1 km.) west of the railway station, Lodi, Columbia County; all in Wisconsin.

(**339g**) Just below the *Dicellocephalus minnesotensis* zone, near Winona, Winona County, Minnesota.

(**341**) Sandstone near Lansing, Allamakee County, Iowa.

FINKELNBURGIA OSCEOLA CORRUGATA (Walcott).

Orthis (*Finkelnburgia*) *osceola corrugata* WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 280. (Characterized as below as a new variety.)

At two of the localities at which *Finkelnburgia osceola* (Walcott) occurs there are also found a few specimens with strong concentric ridges formed by the piling up of lines of growth. The shell has a corrugated appearance that is very distinctive, and it is designated a variety.

FORMATION AND LOCALITY.—**Upper Cambrian:** (**78** and **78s**)[b] *"St. Croix sandstone," quarry near St. Croix River, in the suburbs of Osceola, Polk County, Wisconsin.*

(**339g**) Just below the *Dicellocephalus minnesotensis* zone, near Winona, Winona County, Minnesota.

Superfamily STROPHOMENACEA Schuchert.

Family STROPHOMENIDÆ King.

Subfamily RAFINESQUINÆ Schuchert.

Genus EOSTROPHOMENA Walcott.

[ἠώς, dawn; and Strophomena (στροφή, a twist; and μήνη, the moon, a crescent).]

Strophomena (*Eostrophomena*) WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 256. (Characterized as below as a new subgenus.)

Eostrophomena WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 148. (Classification of genus.)

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[a] **83** is the type locality.

[b] **83′** is the type locality.

The description of the type species gives all that is known of the genus. It differs from *Strophomena* in having the cardinal process in the dorsal valve merged into a ridge formed by the extension of the crural plates along the posterior margin so as to cover the delthyrium and unite at the median line.

Type.—*Strophomena* (*Eostrophomena*) *elegantula* Walcott.

Observations.—The cardinal process is more like that of *Orthothetes* than that of *Strophomena;* it differs from both in being more simple in its construction. It is probable that there is a group of shells having the characters of *Eostrophomena elegantula* (Walcott), but owing to the difficulty of obtaining interiors of the valves, it is impossible to designate them. *Strophomena aurora* Billings [1865a, p. 218] is one of these; also, *Leptæna decipiens* [Billings, 1862c, p. 74].

Eostrophomena elegantula (Walcott).

Plate XCV, figures 6, 6a–b.

Strophomena (*Eostrophomena*) *elegantula* Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 256–257. (Described and discussed as below as a new species.)

Strophomena (*Eostrophomena*) *walcotti* Moberg and Segerberg, 1906, Medd. från Lunds Geol. Fältklubb, Ser. B, No. 2 (Aftryck ur K. Fysiografiska Sällskapets Handl., N. F., Bd. 17), p. 71, Pl. II, figs. 6, 6a–b; Pl. III, fig. 16?. (Described and discussed in Swedish. The specific name "*walcotti*" is proposed because of the preoccupation of "*elegantula.*" The generic value now assigned to *Eostrophomena* permits the use of "*elegantula.*" Figs. 6, 6a–b, in common with the remaining figures on Pl. II of Moberg and Segerberg's paper, were copied from a preliminary photograph of Pl. XCV of this monograph.)

General form transversely subsemicircular or subelliptical, greatest width at the straight hinge line. Surface concavo-convex and marked by fine, radiating, even striæ, separated into flat bands by stronger and more prominent striæ or ribs; fine concentric striæ, and more or less prominent lines of growth cross the radiating striæ. The ventral valve is slightly convex, with low umbo and small, incurved apex. The dorsal valve is flattened in the umbonal region and concave toward the margins; the interior shows a narrow, rounded median furrow, also rounded crural plates that unite with the cardinal process to form a continuous ridge covering the anterior portion of the delthyrium; the dental sockets appear to have been relatively large and deep; the adductor muscle scars are a little to the front, as shown in figure 6b.

A ventral valve 6 mm. wide has a length of 4 mm., and a dorsal valve 5.5 mm. wide is 3 mm. in length.

Observations.—The concavo-convex shells and the ridge representing the cardinal process place this little shell with the strophomenoid forms, but as no described genus possesses the characters shown a genus is made to receive it.

Formation and locality.—Passage beds between the Upper Cambrian and the Ordovician: (**310j**) *Ceratopyge limestone, at Borgholm;* (**310** [Moberg and Segerberg, 1906, description of Pl. III]) *Ceratopyge* limestone (Zone 4) at Ottenby; and (**390e** [Moberg and Segerberg, 1906, pp. 71 and 109]) "*Apatocephalus* zone of the *Ceratopyge* suite," at Ottenby; all on Oeland Island, Sweden.

Superfamily PENTAMERACEA Schuchert.

Family SYNTROPHIIDÆ Schuchert.

Genus SWANTONIA Walcott.[a]

Swantonia Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 296. (Mentioned as below as a new genus.)

Swantonia Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 148. (Classification of genus.)

The description of the type species includes that of the genus, as there is only one other species now referred to the genus, and that is very imperfectly known.

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[a] Prior to the definition of the genus *Swantonia* the species now placed under that genus were referred to the following genera:

Camerella Billings [1861b, p. 10; 1861c, p. 949; 1862e, p. 221; 1863, p. 284].
Camarella Walcott [1886b, p. 122; 1891a, p. 613].
Camarella? Hall and Clarke [1893, p. 220].
Protorhyncha? Schuchert [1897, p. 334].

Type.—Camerella antiqua Billings [1861b, p. 10].

The generic name is derived from the town of Swanton, Vermont, near which the type species occurs.

Swantonia antiquata (Billings).

Plate CIV, figures 5, 5a–b.

Camerella antiquata Billings, 1861, Geol. Survey Canada, Paleozoic Fossils, vol. 1, pp. 10–11, fig. 13, p. 10. (Described and discussed as a new species.)

Camerella antiquata Billings, 1861, Report on the Geology of Vermont, vol. 2, p. 949, fig. 353. (Copy of preceding reference.)

Camerella antiquata Billings, 1862, Report on the Economic Geology of Vermont, by Hager, p. 221, fig. 353. (Copy of Billings, 1861b, pp. 10–11, and fig. 13.)

Camerella antiquata Billings, 1863, Geol. Survey Canada, Fifteenth Rept. Progress, fig. 290, p. 284. (No text reference. Fig. 290 is copied from Billings, 1861b, fig. 13, p. 10.)

Camarella antiquata Billings, Walcott, 1886, Bull. U. S. Geol. Survey No. 30, pp. 122–123, Pl. VII, fig. 8. (Original description, Billings, 1861b, pp. 10–11, copied. The specimen represented by fig. 8 is redrawn in this monograph, Pl. CIV, fig. 5.)

Camarella antiquata Billings, Walcott, 1891, Tenth Ann. Rept. U. S. Geol. Survey, p. 613, Pl. LXXII, fig. 3. (No text reference. Fig. 3 is copied from fig. 8 of the preceding reference.)

Camarella ? antiquata Billings, Hall and Clarke, 1893, Nat. Hist. New York, Paleontology, vol. 8, pt. 2, pp. 220–221. (Mentioned in discussion of genus *Camarella*.)

Protorhyncha ? antiquata (Billings), Schuchert, 1897, Bull. U. S. Geol. Survey No. 87, p. 334. (Merely changes generic reference.)

Swantonia antiquata (Billings), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 296–297. (Described and discussed as below.)

Ventral valve ovate, moderately convex; apex pointed and incurved over the area nearly to the plane of the margins of the valve; surface marked by from 8 to 12 or more rounded ribs that extend back well toward the apex; a slight flattening of the median portion suggests that a shallow median sinus may be found on old shells. The shell illustrated has a length and width of 11 mm.

A cast of the interior of a ventral valve shows no traces of muscle scars or vascular markings; two strong teeth are indicated, also a narrow, strong, concave shelf or area; the area or shelf is free from contact with the bottom of the valve, a recess or chamber existing beneath it.

Observations.—The area or shelf may be considered as a short, free spondylium, corresponding to the short spondylium of *Camarella volborthi* Billings as illustrated by Hall and Clarke [1892c, Pl. LXII, fig. 18]. *Swantonia* is closely related to *Camarella*, but it differs in the absence of a supporting median septum beneath the spondylium of the ventral valve. No specimens of the dorsal valve have been observed.

Formation and locality.—**Lower Cambrian**: (319e)[a] Sandy shales 2 miles (3.2 km.) east of Swanton, Franklin County, Vermont.

Swantonia weeksi Walcott.

Plate CIV, figure 6.

Swantonia weeksi Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 297. (Characterized as below as a new species.)

This shell has the general form of *Swantonia antiquata* (Billings), but the ribs are finer, more numerous, and crossed by fine, sharp, concentric striæ. Only the exterior of the ventral valve appears to be represented in the collection made by Mr. F. B. Weeks.

Formation and locality.—**Lower Cambrian**: (1v) Shales of No. 3 of the Silver Peak group, Barrel Spring section [Walcott, 1908f, p. 189], 3 miles (4.8 km.) north of Valcalda Spring and 4 miles (6.4 km.) west-northwest of the Drinkwater mine, Silver Peak quadrangle (U. S. Geol. Survey), Esmeralda County, Nevada.

[a] Billings [1861b, p. 11] gives the locality as 1.5 miles (2.4 km.) east of Swanton, Vermont.

Genus SYNTROPHIA Hall and Clarke.[a]

Syntrophia Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, footnote, p. 270. (Discusses species which appear to belong to a distinct genus and announces the future use of the term *Syntrophia* to include them.)

Syntrophia Hall and Clarke, 1893, idem, pt. 2, pp. 216–218. (Described and discussed as a new genus, copying the original note proposing the genus. The description of "*Triplesia lateralis*" Whitfield, which is given on p. 217, is copied in this monograph; see below.)

Syntrophia Hall and Clarke, Hall, 1894, Thirteenth Ann. Rept. State Geologist New York for 1893, vol. 2, pp. 836–837. (Copies the description of "*Triplesia lateralis*" given on p. 217 of the preceding reference.)

Syntrophia Hall and Clarke, Walcott (in part), 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 288–289. (Gives an essential copy of the description of "*Triplesia lateralis*" given by Hall and Clarke, 1893b, p. 217, a description which is copied below, and discusses the genus essentially as below. Species were included in the genus which are now placed under *Huenella*.)

Syntrophia Hall and Clarke, Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 270. (Described.)

Syntrophia Hall and Clarke, Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 4, Pl. XI, and pp. 142 and 148. (Classification of genus.)

The description of "*Triplesia lateralis*" by Hall and Clarke [1893b, p. 217] follows:

Shell transversely elongate, biconvex with a straight hinge line whose length nearly equals the greatest diameter of the valves, and each valve is medially divided by an open delthyrium. The external surface is smooth, with fine concentric lines visible only about the margins; the inner shell layers show a strongly fibrous radiating structure without punctation. The pedicle valve bears a more or less clearly developed median sinus and the brachial valve a broad, indistinct fold.

On the interior the teeth are very small, lying at the extremities of the delthyrial margins and supported by dental plates which converge and unite before reaching the bottom of the valve. Thus is formed a deep but short spondylium, which is supported, near its apical portion, by a median septum, but is free for fully one-half its length.

In the brachial valve there are also two convergent plates bounding the deltidial cavity, larger and stronger than those of the opposite valve. These plates may rest upon the bottom of the valve, and probably always do so toward the posterior extremity, but anteriorly they become free, forming a spondylium which is supported by a median septum extending beyond the anterior edge of the plate. Thus these two valves which are very similar in exterior, the pedicle valve being only slightly the more convex and with a low median sinus, are also closely alike on the interior, each being furnished with a spondylium.

Type.—*Triplesia lateralis* Whitfield.

Observations.—Hall and Clarke [1893b, p. 216] referred *Orthis barabuensis* and *Triplesia primordialis* among Cambrian species to *Syntrophia*, and of Ordovician species, *Triplesia lateralis*, *Stricklandinia? arethusa*, *S.? arachne*, and *Camarella calcifera*.

Orthis? armada Billings, of the Lower Ordovician, certainly has a close resemblance in the spondylium of its ventral valve to this genus, and it may represent a radially striated form, as suggested by Hall and Clarke [1893b, p. 218]. Concerning the relations of *Syntrophia* to *Stricklandinia*, they consider that the structures represented in the species referred to the former genus may be the equivalents of those represented by the Stricklandinias of the later Silurian and Devonian. Billings [1862b, p. 84] noted the relationship existing between his *Camarella calcifera* and *Stricklandinia*. It is probable that *S.? arachne*, *S. arethusa*, and similar forms should be referred to a distinct genus. They are not typical Stricklandinias and they differ in surface and shape from *Syntrophia lateralis*.

The Cambrian type of *Syntrophia* is *S. rotundata* of the Upper Cambrian. It has a spondylium in each valve supported by a median septum, and a short area divided by a large open delthyrium.

The structure of the shell of *Syntrophia* is fibrous, with rows of minute pores between the fibers.

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[a] The synonymy for this genus does not give a complete record of the various genera under which the species now included in *Syntrophia* were formerly placed; it gives only those references in which the genus is discussed or described. To complete the record for the species taken up in this monograph the following mere generic references are listed:

Camerella Billings [1861a, p. 318; 1863, p. 231].
Orthis A. Winchell [1864, p. 228].
Camerella Billings [1865a, p. 220].
Triplesia Whitfield [1878, p. 51].
Leptæna Whitfield [1878, p. 60; 1882, pp. 171 and 195].
Triplesia Whitfield [1882, p. 172].
Triplesia Walcott [1884b, p. 75].
Triplesia Whitfield [1886, p. 303].
Triplecia Hall and Clarke [1892c, p. 270].

All of the species of the Syntrophiidæ with nonplicated, smooth surface and spondylium raised on a median septum are referred to *Syntrophia*, and the species with a more or less plicate surface, with sessile spondylium or pseudospondylium, to the genus *Huenella*. The nonplicate or smooth species are: *S. cambria* and *S.? unxia* of the Middle Cambrian; *S. alata*, *S. barabuensis*, *S. campbelli*, *S. orthia*, *S. primordialis*, and *S. rotundata* of the Upper Cambrian; and *S. calcifera*, *S. lateralis*, and *S. nundina* of the Ordovician.

Syntrophia alata Walcott.

Plate CIII, figures 3, 3a–e.

Syntrophia alata Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 290. (Characterized as below as a new species.)

This species is characterized by its transverse form and extended cardinal angles. Exterior surface marked by concentric striæ and lines of growth and interior surface by fine, radiating striæ. A transverse section of the ventral valve at the umbo shows the spondylium with a strong median septum supporting it. The interior of the ventral valve was marked by two strong main vascular sinuses starting from the sides of the spondylium.

Formation and locality.—**Upper Cambrian:** (**69**) Limestone near Honey Creek, Burnet County, Texas.

Syntrophia barabuensis (A. Winchell).

Plate CII, figures 1, 1a–g.

Orthis barabuensis A. Winchell, 1864, Am. Jour. Sci., 2d ser., vol. 37, p. 228. (Described and discussed as a new species.)

Leptæna barabuensis (Winchell), Whitfield, 1878, Ann. Rept. Wisconsin Geol. Survey for 1877, p. 60.

Leptæna barabuensis (Winchell), Whitfield, 1882, Geology of Wisconsin, vol. 4, pt. 3, pp. 171–172, Pl. I, figs. 6 and 7. (Described and discussed; see below for copy.)

Leptæna barabuensis Winchell, Whitfield, 1882, idem, p. 195, Pl. III, fig. 6. (Described from a higher horizon than that containing the specimens referred to in the preceding.)

Syntrophia barabuensis (Winchell), Hall and Clarke, 1893, Nat. Hist. New York, Paleontology, vol. 8, pt. 2, p. 216. (Changes generic reference.)

Syntrophia barabuensis (Winchell), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 27, pp. 290–291. (Description by Whitfield copied, and species discussed as below.)

The description by Whitfield [1882, pp. 171–172] follows:

Shell of medium size or smaller, measuring about half an inch or less than half an inch along the hinge line; form semielliptical, longest on the hinge and more than half as wide again as long; extremities of the hinge often submucronate; front of the valves rounded or slightly emarginate in the middle. Ventral valve the most convex, and marked by a strong, angular mesial elevation, nearly one-fourth as wide on the front of the valve as the width of the shell; area moderately high and nearly in the plane of the valve; cardinal borders very gradually sloping from the center to the extremities of the cardinal line. Dorsal valve less convex than the opposite, and marked by a subangular mesial depression, corresponding to the fold of the opposite valve; area linear. Surface of the shell apparently smooth, or at least so far as can be determined from either the internal casts or from the matrix.

I had some doubt regarding the positive identity of this species with that described by Professor Winchell [1864, p. 228] in consequence of the following remarks which occur in his description: "Surface with sixteen or eighteen ribs visible on the casts, the strongest of which limit the mesial sinus," and again, "apparently of the type of *Orthis biforta*." In examining a number of specimens, I had not been able to detect any striæ or ribs, and felt somewhat inclined to regard it as a distinct species from that one. I have, however, through the kindness of Prof. W. [Winchell], been able to make a direct comparison with one of his original specimens, and should consider them as identical. The specimen sent me has the mesial fold (of the ventral valve) remarkably strongly defined by a depressed line on each margin, the center appearing tumid, which I think is in part due to accident. The specimen corresponds closely with the ventral valve we have figured, except in the strongly defined mesial fold.

Observations.—This is the same type of *Syntrophia* as *S. primordialis*. It differs in its more rounded outlines, shallow, rounded sinus in the ventral valve, and, usually, a less pronounced fold on the dorsal valve. Evidence of a short median septum at the end of a very short spondylium in the dorsal valve is shown by one cast (Pl. CII, fig. 1g).

The species derives its specific name from its occurrence at Devils Lake, which is near Baraboo, Sauk County, Wisconsin.

Formation and locality.—**Upper Cambrian:** "St. Croix sandstone" at the following localities: (**328** [*Whitfield, 1882, p. 172*]) *Upper layers near the north end of Devils Lake, Sauk County;* (**81b**) near Devils Lake, Sauk County; (**81o**)

on the railroad track below the Cliff House, Devils Lake, Sauk County; (83) near Trempealeau, Trempealeau County; (78) quarry near St. Croix River in the suburbs of Osceola, Polk County; and (134a) in a quarry 1 mile (1.6 km.) southeast of the county courthouse in Menomonie, Dunn County; all in Wisconsin.

Syntrophia calcifera (Billings)

Plate CIV, figures 1, 1a–i.

Camerella calcifera Billings, 1861, Canadian Naturalist, vol. 6, pp. 318–320, figs. 3a–c, p. 319. (Described and discussed as a new species. Figs. 3a–c are copied in this monograph, Pl. CIV, figs. 1, 1a, and 1b, respectively.)

Camarella calcifera Billings, 1863, Geol. Survey Canada, Fifteenth Rept. Progress, figs. 247a–c, p. 231. (No text reference. Figs. 247a–c are copied from figs. 3a–c of the preceding reference.)

Camerella calcifera Billings, 1865, Geol. Survey Canada, Paleozoic Fossils, vol. 1, p. 220. (Localities mentioned.)

Triplecia? calcifera (Billings), Hall and Clarke, 1892, Nat. Hist., New York, Paleontology, vol. 8, pt. 1, p. 270. (Merely changes generic reference.)

Syntrophia? calcifera (Billings), Hall and Clarke, 1893, idem, pt. 2, p. 218, Pl. LXII, fig. 24. (Changes generic reference.)

Syntrophia calcifera differs from *S. nundina* in its more pointed and incurved apex, stronger ventral sinus, and dorsal fold. It is more convex and rotund than *S. primordialis*.

The only interior parts known are in the form of a cast illustrated by Billings [1861a, fig. 3c, p. 319] and copied in Plate CIV, figure 1b; this indicates a well-developed spondylium and a median supporting septum in the ventral valve.

The form owes its specific name to its occurrence in the "calciferous sandrock."

Formation and locality.—**Lower Ordovician**: (**319t**)[a] "Calciferous sandrock" at St. Timothy on the St. Lawrence, near the head of the Beauharnois Canal; (**319u** [Billings, 1861a, p. 320]) "calciferous sandrock" in the Township of Edwardstown, between Beauharnois and Lake Champlain; (**392**)[a] at Nortons Creek; (**392j**)[a] *limestones of the "Quebec group" at Point Levis;* and (**392i**)[a] limestone at Phillipsburgh; all in the Province of Quebec, Canada.

(**314c**)[a] Nodules of white limestone belonging to Division P of Billings's section at Cow Head, Newfoundland.

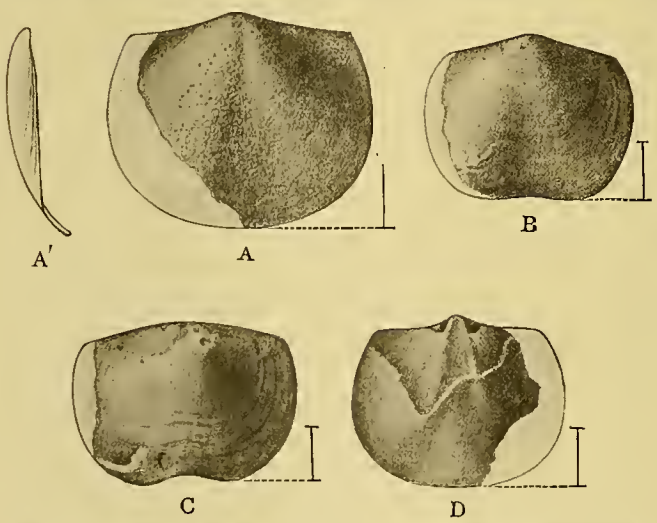

Figure 72.—*Syntrophia cambria* Walcott. A, A′, Top view and side outline of ventral valve (U. S. Nat. Mus. Cat. No. 57029a). B, Ventral valve, the type specimen (U. S. Nat. Mus. Cat. No. 52477a). C, Dorsal valve (U. S. Nat. Mus. Cat. No. 52478). D, Partly exfoliated ventral valve (U. S. Nat. Mus. Cat. No. 52477c).

Figures 72B and 72C are copied from Walcott [1908d, Pl. X, figs. 11 and 11a]. The specimen represented by figure 72C is from Locality **34m**; those represented by figures 72A, 72B, and 72D are from Locality **32e**; and that represented by figure 72A is from Locality **31c**, all in the Middle Cambrian of northeastern Utah.

Syntrophia cambria Walcott.

Text figures 72A–D.

Syntrophia cambria Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 106–107, Pl. X, figs. 11 and 11a. (Described and discussed as a new species. With the exception of the third paragraph the reference is copied below. Figs. 11 and 11a are copied in this monograph as figs. 72B and 72C, respectively.)

General form transversely oval, strongly convex but not rotund. Ventral valve moderately convex, with the frontal margin in adult shells prolonged; a flattened median sinus begins on the umbo and widens to two-thirds the width of the shell in front; area unknown. Dorsal valve moderately convex except on the median fold, which is rounded but not unusually prominent; area unknown.

Surface marked by a few concentric lines of growth. The largest dorsal valve has a length of 8 mm.; width, 11 mm. A ventral valve 9 mm. in length has a width of 14 mm.

[a] Billings, 1865a, p. 220.

Observations.—In form this species is usually most nearly related to *Syntrophia calcifera* (Billings) (Pl. CIV, figs. 1, 1a–i). It differs in having a less clearly defined beak and less prominent fold on the dorsal valve. There are many points in common between *Syntrophia cambria* and *S. nundina* Walcott (Pl. CII, figs. 4, 4a–c), but they differ in the shorter beak and sharper median fold of the latter. *Syntrophia cambria* occurs in the Wasatch range, about 4,500 feet below the base of the Ordovician, while *S. calcifera* and *S. nundina* occur in the Lower Ordovician. It is the oldest species of the genus and is of interest also on account of being closely related in form to the Ordovician species mentioned.

FORMATION AND LOCALITY.—**Middle Cambrian**: (**31c** and **54o**) 900 feet (274.3 m.) above the Brigham quartzite and 3,300 feet (1,005.8 m.) below the Upper Cambrian, in the limestone forming 1b of the Ute limestone [Walcott, 1908f, p. 196], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County; (**32e**) *the same stratigraphic horizon as Locality 31c just south of the south fork of Paradise Dry Canyon (East Fork), east of Paradise, Cache County;* and (**34m**) limestone about 765 feet (233.2 m.) above the Brigham quartzite [Walcott, 1908a, p. 8], 1 mile (1.6 km.) northwest of Geneva (Copenhagen), east of Brigham, Boxelder County; all in Utah.

SYNTROPHIA CAMPBELLI Walcott.

Text figures 73A–F.

Syntrophia campbelli WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 107–108, Pl. X, figs. 9, 9a–c. (Described and discussed as below as a new species. Figs. 9, 9a–c are copied in this monograph as figs. 73B, 73C, 73E, and 73F, respectively.)

General form rotund, unequally biconvex; hinge line short. Ventral valve moderately convex, exclusive of the prolonged frontal margin; it is depressed toward the front in adult

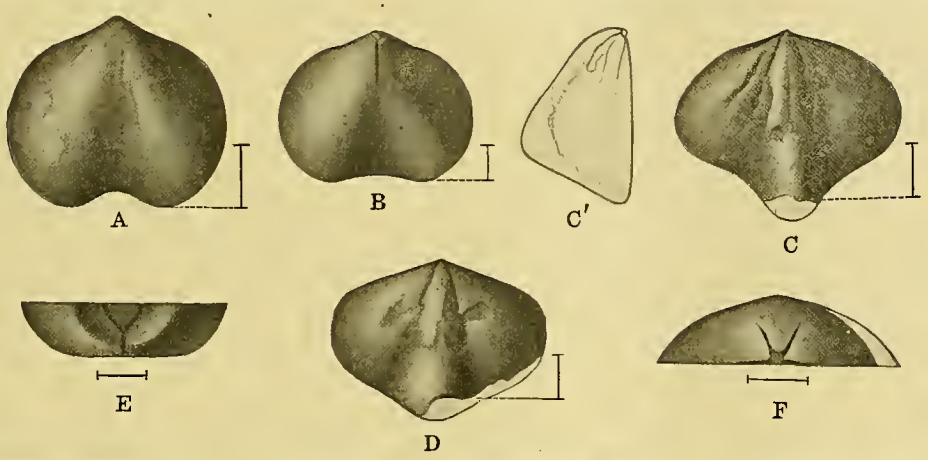

FIGURE 73.—*Syntrophia campbelli* Walcott. A, Ventral valve, the type specimen (U. S. Nat. Mus. Cat. No. 52480f). B, Cast of ventral valve, showing cast of septum supporting the spondylium (U. S. Nat. Mus. Cat. No. 52480a). C, C′, Dorsal valve (U. S. Nat. Mus. Cat. No. 52480b). D, Dorsal valve (U. S. Nat. Mus. Cat. No. 52480e). E, Section of ventral valve, showing cast of septum and spondylium (U. S. Nat. Mus. Cat. No. 52480c). F, Cast of dorsal valve, showing cast of spondylium (U. S. Nat. Mus. Cat. No. 52480d).

The specimens represented are from Locality **12q**, Upper Cambrian, near Rogersville, Tennessee. Figures 73B, 73C, 73E, and 73F are copied from Walcott [1908d, Pl. X. figs. 9, 9a–c, respectively].

shells by a broad median sinus that disappears on the umbo; area short and divided midway by a relatively large, open, triangular delthyrium. Dorsal valve convex with an elevated, relatively narrow median fold that does not extend back to the beak; area short and divided by a strong, open, triangular delthyrium.

Surface marked by concentric striæ and a few strong lines of growth. The largest shell is represented by a dorsal valve that has a length of 12 mm.; width, 14 mm. A ventral valve 7 mm. in length has a width of 11 mm.

Casts of the ventral valve show a spondylium supported on a septum that extended from the beak about one-third the distance to the front margin. The spondylium of the dorsal valve rests directly on the interior of the shell without trace of a supporting median septum.

Observations.—The young shells of this species are almost evenly convex, the fold of the dorsal valve and the sinus of the ventral valve of the adult shell not having developed. The characteristic spondylium of each valve is shown in the youngest shells observed. The general form of *Syntrophia campbelli* is much like that of *Syntrophia rotundata* Walcott (Pl. CIII, figs. 4, 4a–c) and somewhat like that of *Huenella texana* (Walcott) (Pl. CIII, figs. 1, 1a–g). It differs from the former in having the spondylium of the dorsal valve resting on the interior of the shell and not supported on a septum, in this respect resembling the spondylium of *Huenella texana* (Walcott) (Pl. CIII, figs. 1h, 1i). Some shells have a somewhat transverse posterior margin like that of *H. texana*, but the larger number have the broadly acuminate outline of *S. rotundata*. The muscle scars of the dorsal valve, as far as known, are similar to those of *Huenella abnormis* (Walcott) (Pl. CIII, figs. 2i, 2s).

The specific name was given in honor of Mr. M. R. Campbell of the United States Geological Survey, who collected the specimens.

Formation and locality.—**Upper Cambrian:** (**12q**) Knox dolomite, on Bunker Hill, 6 miles (9.6 km.) northeast of Rogersville [Keith, 1905, areal geology sheet], Hawkins County, Tennessee.

Syntrophia lateralis (Whitfield).

Text figure 11, page 299; Plate CII, figures 6, 6a–g.

Triplesia lateralis Whitfield, 1886, Bull. Am. Mus. Nat. Hist. No. 8, p. 303, Pl. XXIV, figs. 9–11. (Described as a new species.)

Syntrophia lateralis (Whitfield), Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. I, footnote, p. 270. (Generic reference changed.)

Syntrophia lateralis (Whitfield), Hall and Clarke, 1893, idem, vol. 8, pt. 2, p. 217, Pl. LXII, figs. 1–10. (Described, giving on p. 216 the footnote referred to in the preceding reference. The description of this species is copied in this monograph, under the genus *Syntrophia*. Figs. 9 and 10 are copied in this monograph, Pl. CII, figs. 6f and 6g, respectively.)

Syntrophia lateralis (Whitfield), Hall and Clarke, 1894, Thirteenth Ann. Rept. State Geologist New York for 1893, vol. 2, pp. 836–837, Pl. XLV, figs. 7–12. (Copy of the description given on p. 217 of the preceding reference. Figs. 7–12 are copied from Hall and Clarke, 1893b, Pl. LXII, figs. 1, 2, 6, 9, 5, and 10, respectively.)

I have illustrated a few of the shells representing the species that, taken with those of Hall and Clarke in part 2 of volume 8 of their great work, illustrate about all that is known of *S. lateralis*. (See p. 798 for a copy of Hall and Clarke's description of the species.)

Formation and locality.—**Lower Ordovician:** (**227**) Limestone near Fort Cassin, Addison County, Vermont.

Syntrophia nundina Walcott.

Plate CII, figures 4, 4a–d.

Triplesia calcifera Walcott [not Billings], 1884, Mon. U. S. Geol. Survey, vol. 8, pp. 75–76, Pl. XI, figs. 7 and 8. (Characterized. The specimens represented by figs. 7 and 8 are redrawn in this monograph, Pl. CII, figs. 4 and 4a, respectively.)

Syntrophia nundina Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 292. (Characterized as below as a new species.)

Syntrophia calcifera Walcott, Grabau and Shimer, 1907, North American Index Fossils, vol. 1, p. 271, figs. 325. (Described. The two figures in fig. 325 are copied from Walcott, 1884b, Pl. XI, figs. 7 and 8, respectively.)

The nonplicate, convex species that is found in the Lower Ordovician of the western United States has usually been referred to *Camerella* or *Triplesia calcifera*. It is much like the latter but differs in being less convex, with apex of valves less pointed and incurved.

Formation and locality.—**Lower Ordovician:** Pogonip limestone at the following localities: (**63**) Northeast of Adams Hill; (**201a**) east slope of the ridge east of Hamburg Ridge; (**203**) on spur on ridge extending southwest from Wood Cone; (**204**) *on the lower part of the eastern slope of the ridge east of Hamburg Ridge, facing Secret Canyon road;* and (**209**) on the west side of Goodwin Canyon; all in the Eureka district [Hague, 1892, Atlas], Eureka County, Nevada.

(**185z**) Limestones at the base of the Lower Ordovician [Walcott, 1908f, p. 191], in Blacksmith Fork Canyon, about 9 miles (14.4 km.) east of Hyrum, Cache County, Utah.

(**186** and **186a**) Near line of contact between red and gray Ordovician limestone, in red siliceous limestone, 30 to 35 feet (9.1 to 10.7 m.) above the pre-Cambrian rocks, Williams Canyon, Manitou, El Paso County, Colorado.

Upper Cambrian: (**54b**) About 1,200 feet (365.8 m.) above the Middle Cambrian and 25 feet (7.6 m.) below the top of the Upper Cambrian in the upper part of the limestone forming 1 of the St. Charles formation [Walcott, 1908f,

p. 191]; and (54c) about 1,100 feet (335.3 m.) above the Middle Cambrian and 120 feet (36.6 m.) below the top of the Upper Cambrian in the central part of the limestone forming 1 of the St. Charles formation [Walcott, 1908f, p. 192]; both in Blacksmith Fork Canyon about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

A specimen (Pl. CII, fig. 4d) that is somewhat doubtfully referred to this species occurs at the following locality:

Upper Cambrian: (329a) Limestone on Ute Peak, in the Wasatch Mountains east of Cache Valley, Cache County, Utah.

Syntrophia orthia Walcott.

Plate CIV, figures 4, 4a–b.

Syntrophia orthia Walcott, 1905, Proc. U. S. Nat. Mus., vol. 29, pp. 11–12. (Described and discussed as a new species.)

General form irregularly oval, with the ventral view obtusely angular toward the apex; rounded, biconvex, with a deep mesial sinus on the ventral valve and a strong median fold on the anterior half of the dorsal valve. Surface smooth, with the exception of a few concentric striæ and lines of growth. The ventral valve has a strong median sinus that occupies about one-third of the width of the valve at the anterior margin and projects forward to fit into the sinus in the front of the margin of the dorsal valve; the sides of the median sinus are elevated, and with the downward-sloping lateral slopes form a strong, rounded ridge on each side of the sinus; none of the specimens in the collection show the area, but from the profile of the valve it must have been of moderate height, with a rather sharp apex curving over it.

Dorsal valve with a minute apex, from which a narrow, slightly developed median fold extends to about the posterior fourth of the shell, where it becomes elevated, and, widening, extends forward to the front margin; the remaining portions of the surface are uniformly convex, sloping away from the median fold to the margins of the valve.

Nothing is known of the interior of either valve.

Observations.—In general form this species resembles *Syntrophia primordialis* (Whitfield) of the "St. Croix sandstone" of Wisconsin. It differs in its more rounded, irregularly oval form and the very large median sinus of the ventral valve.

Formation and locality.—**Upper Cambrian**: (C54) Lower part of the Chaumitien limestone [Blackwelder, 1907a, p. 42 (part of last list of fossils)], 0.66 mile (1.1 km.) west of Tsinan; (C56) *same horizon as Locality C54 at Pagoda Hill [Blackwelder, 1907a, p. 42 (part of last list of fossils)], 1 mile (1.6 km.) west of Tsinan;* and (C64) upper limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 42 (first list of fossils), and fig. 10 (bed 20), p. 38], 2.7 miles (4.3 km.) southwest of Yenchuang, Sintai district; all in Shantung, China.

Syntrophia primordialis (Whitfield).

Plate CII, figures 2, 2a–e.

Triplesia primordialis Whitfield, 1878, Ann. Rept. Wisconsin Geol. Survey for 1877, p. 51. (Described.)

Triplesia primordialis Whitfield, 1882, Geol. Wisconsin, vol. 4, pt. 3, p. 172, Pl. X, figs. 1 and 2. (Described and discussed, the first paragraph being copied below.)

Triplecia? primordialis Whitfield, Hall and Clarke, 1892, Nat. Hist. New York, Paleontology, vol. 8, pt. 1, p. 270, footnote. (Questions generic reference.)

Syntrophia primordialis (Whitfield), Hall and Clarke, 1893, idem, pt. 2, p. 218. (Changes generic reference.)

Syntrophia primordialis (Whitfield), Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 292. (Whitfield's description, 1882, p. 172, copied and species discussed as below.)

The description by Whitfield [1882, p. 172] follows:

Shell small, measuring less than half an inch in width; transversely oval in outline, and quite ventricose in profile; hinge line straight and about half as long as the width of the shell below; area narrow. Ventral valve with a strongly depressed, rather narrow and rounded mesial sinus. Dorsal valve with a narrow, sharply elevated fold not extending quite to the beak; sides of the valve rounded. Surface smooth in the casts, but presenting the appearance of having been externally striate. Processes in the interior of the dorsal valve apparently forming a small spoon-shaped pit at the beak.

Observations.—Casts of the interior show the form of the spondylium and supporting median septum in the ventral valve; also, a small short spondylium in the ventral valve, which appears to be attached to the bottom of the valve without a median septum.

This species differs from *Syntrophia barabuensis* (Winchell) in its smaller size, less transverse outline, and more pronounced mesial depression on the ventral valve. Some specimens of the dorsal valves of the two species are very similar. These are shown by Plate CII, figures 1f and 2c. Some of the shells approach certain forms of *S. calcifera*, but the larger number are less convex and more transverse and with more obtuse cardinal angles. A shell closely allied to *S. primordialis*, and apparently identical, occurs in the limestone of the Reagan sandstone of Oklahoma. Only the exterior is known.

FORMATION AND LOCALITY.—**Upper Cambrian**: "St. Croix sandstone" at the following localities: (**99**) Minneiska (Miniska), on Mississippi River, near the line between Wabasha and Winona counties; (**339d**) Taylors Falls, Chisago County; (**84a**) at River Junction, Houston County, 20 miles (32.2 km.) below Dresbach, and (**339g**) just below the *Dikellocephalus minnesotensis* beds, near Winona, Winona County; all in Minnesota.

(**328k**) *"St. Croix sandstone" at Roche à Cris Bluff, Adams County, Wisconsin.*

(**9u**) About 195 feet (59.4 m.) above the porphyry contact in the limestones of the Reagan sandstone, in SE. ¼ NE. ¼ sec. 2, T. 4 N., R. 13 W., 15 miles (24.2 km.) northwest of Fort Sill, Comanche County; and (**12n**) limestones of the Reagan sandstone (in the section 7 miles (11.2 km.) north of Springer this horizon is about 240 feet (73 m.) above the porphyry contact and 40 feet (12 m.) below the Arbuckle limestone), NW. ¼ sec. 1, T. 2 S., R. 1 E., Ardmore quadrangle (U. S. Geol. Survey), Carter County; both in Oklahoma.

(**168**) Limestones on north side of Tepee Creek, near the road from Sheridan to Dome Lake, Bighorn Mountains, Sheridan County, Wyoming.

SYNTROPHIA PRIMORDIALIS ARGIA Walcott.

Plate CII, figure 3.

Syntrophia primordialis argia WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 293. (Characterized as below as a new variety.)

This specimen is separated as a variety of *Syntrophia primordialis* (Whitfield) on account of its less convexity and more shallow median sinus, which has three rudimentary plications in it.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**97**) "St. Croix sandstone" at Reads Landing, foot of Lake Pepin, Wabasha County, Minnesota.

SYNTROPHIA ROTUNDATA Walcott.

Plate CIII, figures 4, 4a–e.

Syntrophia rotundata WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 293–294. (Described and discussed as below as a new species.)

General form rotund, unequally biconvex; hinge line short. Surface marked by fine, concentric striæ and low, imbricating varices of growth. The largest shell observed has a width of 13 mm.; length, 11 mm. Ventral valve convex at the umbo and beak, but depressed toward the front by a strong, broad, and deep median sinus. Area low, short, and divided midway by a relatively large triangular delthyrium. Transverse sections of the umbo near the beak show the cross section of a well-developed spondylium supported on a median septum. Dorsal valve about as convex as the ventral on the umbo, but the strong, broad median fold makes it strongly convex. Cross sections at the umbo show a spondylium and supporting septum very much like that in the ventral valve.

Observations.—This species is taken as the Cambrian representative of the genus *Syntrophia*. It has a spondylium in each valve supported by a median septum in the same manner as in the Ordovician type of the genus *S. lateralis*. Its rotund form, deep ventral sinus, and strong dorsal fold serve to distinguish *S. rotundata* from other species of the genus.

FORMATION AND LOCALITY.—**Upper Cambrian**: (**14k**) Limestone on Wolf Creek, 15 miles (24.2 km.) west-southwest of Sheridan, Bighorn Mountains, Sheridan County, Wyoming.

SYNTROPHIA? UNXIA Walcott.

Text figure 74, page 805.

Syntrophia? unxia WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 108–109, Pl. X, fig. 10. (Discussed as below as a new species. Fig. 10 is copied on p. 805 as fig. 74.)

This species is represented by a single specimen of the ventral valve from which the shell has been removed by weathering. The cast of the spondylium shows it to have been

of the same type as that of the ventral valve of *Syntrophia primordialis* (Whitfield) (Pl. CII, figs. 2, 2a–b) and *S. barabuensis* (Winchell) (Pl. CII, figs. 1, 1a–d). The elongate, rounded form and scarcely perceptible median sinus serve to distinguish this species from all described forms.

This is the oldest shell of this type known to me. It occurs 5,525 feet below the summit of the Cambrian, in the House Range section. I am not fully satisfied with the generic reference, but with the data available it can not well be referred to *Billingsella* or any other known genus of the Cambrian Brachiopoda.

FORMATION AND LOCALITY.—**Middle Cambrian**: (3x) About 2,200 feet (670.6 m.) above the Lower Cambrian and 2,200 feet (670.6 m.) below the Upper Cambrian, in the limestones forming 1d of the Marjum limestone [Walcott, 1908f, p. 180], 2.5 miles (4 km.) east of Antelope Springs, in ridge east of Wheeler Amphitheater, House Range [Walcott, 1908f, Pls. XIII and XV], Millard County, Utah.

FIGURE 74.—*Syntrophia? unxia* Walcott. Ventral valve, the type specimen, from which the shell has been entirely removed by weathering (U. S. Nat. Mus. Cat. No. 52499). From Locality 3x, in the Middle Cambrian, House Range, Utah. Copied from Walcott [1908d, Pl. X, fig. 10].

Genus HUENELLA Walcott.[a]

Syntrophia WALCOTT (in part) [not HALL and CLARKE], 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 288–289. (Described and discussed essentially as on p. 798 (under *Syntrophia*), but some of the species included in the genus are now referred to *Huenella*.)

Huenella WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 109. (Characterized and discussed as below as a new genus.)

Huenella WALCOTT, 1908, idem, No. 4, Pl. XI, and pp. 142 and 148. (Classification of genus.)

This genus is proposed to include the more or less plicate species of the Syntrophiidæ that have heretofore been referred by me to the genus *Syntrophia*. They differ from *Syntrophia* in having a more or less radially plicate surface and sessile or pseudospondylia instead of free spondylia supported by a median septum. With the exception of *Huenella vermontana* and possibly *H. etheridgei*, all of the species are from the Upper Cambrian.

The shell structure is fibrous, with many minute pores.

Type.—*Syntrophia texana* Walcott [1905a, p. 294].

The generic name is given in recognition of the thorough and valuable work of Dr. Fr. von Hoyningen-Huene on the "Silurischen Craniaden."

HUENELLA ABNORMIS (Walcott).

Text figure 13, page 299; Plate CIII, figures 2, 2a–m.

Not *Camerella calcifera* BILLINGS, 1861, Canadian Naturalist, 1st ser., vol. 6, No. 4, p. 318. (Referred in this monograph to *Syntrophia calcifera*.)

Camerella calcifera MEEK [not BILLINGS], 1873, Sixth Ann. Rept. U. S. Geol. and Geog. Survey Terr. (for 1872), p. 464 and footnote. (Characterized.)

Syntrophia abnormis WALCOTT, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 289–290. (Described and discussed as below as a new species.)

The general form varies from transverse (Pl. CIII, fig. 2) to elongate (fig. 2c). Valves biconvex, with dorsal very convex in some specimens. Hinge line straight. Surface marked by concentric striæ and imbricating lines of growth crossed by fine, rounded, radiating striæ and a variable number of rounded ribs; specimens occur with four ribs in the sinus of the ventral valve and four on each slope outside the sinus; in other ventral valves only a trace of ribs can be seen; among the specimens of the dorsal valve there are shells without a sign of ribs, figure 2d, and others having from a trace of ribs on the median fold to three ribs on the fold and traces on the lateral slopes. The largest shell has a length of 7 mm.; width, 9 mm. There is great variation in the proportion of the length to the width, as shown by the figures illustrating the species.

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[a] Prior to the definition of the genus *Huenella* the species now referred to that genus were described under the following genera:

Camerella Shumard [1861, p. 221].
Camerella Meek [1873, p. 464].
Orthis or *Orthisina* Etheridge [1905, p. 250].
Syntrophia Walcott [1905a, p. 288].

The ventral valve has a broad, strong sinus that depresses the front of the valve; area well defined, with a large, open delthyrium. Casts of the interior of the ventral valve show a well-marked spondylium and very strong main vascular sinuses, figure 2b; both spondylium and sinuses recall those of *Billingsella plicatella* (Pl. LXXXVI, figs. 3g, 3j). Sections of the ventral valve, cut across the umbo, show the spondylium attached to the bottom of the valve. The flabelliform diductor and adductor muscle scars are clearly shown outside of the vascular sinuses.

Dorsal valve with an elevated median fold that gives a strong convexity to the valve; area low, with a strong, open delthyrium; the interior of the valve shows a shallow spondylium attached to the bottom of the valve posteriorly, and probably supported by a low median septum toward the front (figs. 2i, 2j, section fig. 2m) and well-defined anterior and posterior adductor muscle scars; narrow main vascular sinuses occur (fig. 2h), and slender vascular lines radiate forward from the muscle scars (fig. 2f).

Observations.—This species differs from all allied forms in its variation in outline, convexity, ribs, and internal markings. Some shells approach closely to those of *Huenella texana* (Walcott) (compare figs. 1 and 2 and figs. 1b and 2a, Pl. CIII), but each species has a majority of shells that are quite unlike those of the other. Another point of resemblance is the form of the spondylium as shown by cross sections. A variety of *H. texana* from Cold Creek Canyon, Texas, has some shells that approach those of *H. abnormis* in the extravagant development of the fold on the dorsal valve and sinus on the ventral valve, but in other respects they differ from it. The form of spondylium and plications or ribs suggests the genus *Parastrophia* Hall.

This form was an abnormal representative of the genus *Syntrophia*, to which it was first referred, hence the specific name.

Formation and locality.—**Upper Cambrian:** (**153**) Limestone in ravine on west side of Dry Creek, near the mouth of Pass Creek, about 5 miles (8 km.) north of Hillsdale; and (**157** and **158**) limestone north of East Gallatin River, near Hillsdale; both on the Threeforks quadrangle (U. S. Geol. Survey), Gallatin County, Montana.

(**302p**) Middle limestone of the Deadwood formation, near the summit of the Owl Creek Mountains, 18 miles (29 km.) southwest of Thermopolis, Fremont County, Wyoming.

Middle Cambrian: (**4j**) *Limestone at the head of Deep Creek, Yellowstone National Park, Canyon quadrangle (U. S. Geol. Survey), Wyoming.*

Huenella billingsi (Walcott).

Plate CII, figures 5, 5a–c.

Syntrophia billingsi Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 291–292. (Described and discussed as below as a new species.)

General form transversely subquadrate; rounded; biconvex, with the dorsal valve elevated on the median fold. Surface marked by a few imperfectly developed ribs on some shells, while others have only concentric striæ and lines of growth. Ventral valve with a relatively shallow median sinus, in which obscure, narrow ribs sometimes occur; none of the specimens in the collection show the area, but from the profile of the valve it must have been of moderate height, with the rather sharp apex curving slightly over it; a single poor cast of the interior shows the outline of a spondylium much like that of *S. primordialis;* the evidence of the presence of a median septum is a dark line in front of the end of the cast of the spondylium, which indicates that the shell substance extends down into the limestone and that it is the median septum. Dorsal valve with a small umbo and apex that extend forward into a prominent median fold that may be plicated (Pl. CII, fig. 5c) or smooth; one partly exfoliated shell shows three plications on the fold and three or four on each lateral slope of the valve.

Observations.—This species belongs to the plicate group of the Syntrophiidæ represented by *Huenella texana* (Walcott) and *H. abnormis* (Walcott). It differs from *H. texana* in being less convex and in having a shallower ventral sinus, less prominent dorsal fold, and more obscure plications.

The specific name was given in honor of Mr. E. Billings.

Formation and locality.—**Middle ? Cambrian:** (**28a**) "St. Albans formation," in limestone lentil about 1 mile (1.6 km.) east of Parker's quarry, west of Georgia, Franklin County, Vermont.

Huenella etheridgei Walcott.

Plate LXXXIX, figures 9, 9a.

Orthis (or *Orthisina*) sp. Etheridge, 1905, Trans. Roy. Soc. South Australia, vol. 29, p. 250, Pl. XXV, figs. 9 and 10. (Described as below and discussed. The specimens represented by figs. 9 and 10 are redrawn in this monograph, Pl. LXXXIX, figs. 9 and 9a, respectively.)

Huenella etheridgei Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 109–110, Pl. X, figs. 13 and 13a. (Described and discussed as below, copying the original descriptions. Figs. 13 and 13a are drawn from the specimens represented by figs. 9 and 10 of the preceding reference and are copied in this monograph, Pl. LXXXIX, figs. 9a and 9, respectively.)

Doctor Etheridge describes the ventral valve as follows:

Subquadrilateral, convex, the greatest convexity at about midway in the length of the valve, the sinus gradually deepening and widening toward the front, and bounded laterally by ill-defined folds, one on either side, the surface sloping away on either side rapidly to the lateral margins, and at a very much less angle within the sulcus; there are indications of costæ on the divaricating folds and in the sulcus.

The hinge features are hidden in matrix, nor is the umbo distinctly visible.

He describes the dorsal valve as follows:

Rotundato-quadrate, the cardinal margin as long as the width of the valve, the surface convex, except on the dorso-lateral alations, where it appears to be flattened. There is a central, acute, or pinched-up fold, produced forward, and expanding as it advances. There are indications of the existence of strong, distinct, subradiating costæ.

Whether or no this is the brachial valve of the species represented by the preceding form it is at present impossible to say; the two occur in the same bed, however.

From the study of the various forms of *Huenella* described herein, I think that the two valves belong to one species, and I take pleasure in naming it after Dr. R. Etheridge, jr.

Formation and locality.—**Middle? Cambrian:** (**315c** [Etheridge, 1905, p. 250]) "Archæocyathinæ white limestone" at Wirrialpa, Flinders Range, South Australia.

Huenella lesleyi Walcott.

Text figures 75A–C.

Huenella lesleyi Walcott, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, p. 110, Pl. X, figs. 12 and 12a. (Characterized and discussed as below as a new species. Figs. 12 and 12a are copied in this monograph as figs. 75B and 75A, respectively.)

Only the exterior of the valves of this species is known. In form and outline it is most nearly related to *Huenella texana* (Walcott). It differs from the latter in being broader in proportion to its length, and in having narrow, radiating, rounded ribs over the entire surface.

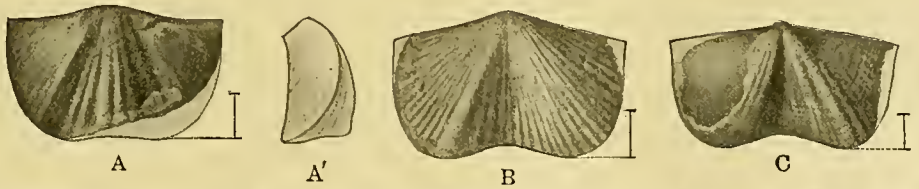

Figure 75.—*Huenella lesleyi* Walcott. A, A′, Exterior of partly exfoliated dorsal valve (U. S. Nat. Mus. Cat. No. 52481b). B, Exterior of ventral valve, the type specimen (U. S. Nat. Mus. Cat. No. 52481a). C, Exterior of ventral valve (U. S. Nat. Mus. Cat. No. 52481c).

The specimens represented are from Locality **54e** in Blacksmith Fork Canyon, Cache County, Utah. Figures 75A and 75B are copied from Walcott [1908d, Pl. X, figs. 12a and 12, respectively].

This is probably the oldest *Huenella.* It occurs 1,025 feet (312.4 m.) below the summit of the Upper Cambrian. *Billingsella coloradoensis* (Shumard) and *Lingulella manticula* (White) occur in the same bed of limestone.

The specific name is given in honor of the late Dr. J. P. Lesley, state geologist of Pennsylvania.

Formation and locality.—**Upper Cambrian:** (**54e**) About 200 feet (61 m.) above the Middle Cambrian and 1,025 feet (212.4 m.) below the top of the Upper Cambrian in limestones forming 3 of the St. Charles formation [Walcott, 1908f, p. 193], in Blacksmith Fork Canyon, about 10 miles (16.1 km.) east of Hyrum, Cache County, Utah.

Huenella orientalis (Walcott).

Plate CIV, figures 3, 3a–b.

Syntrophia orientalis Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 292. (Characterized and discussed as below as a new species.)

This species is closely related in form and surface characters to *Huenella texana* (Walcott) and some forms of *H. abnormis* (Walcott). It differs from them in details of surface ribs. On the dorsal valve there are two or three faintly defined radiating ribs on each side of the median fold, which has obscure ribs upon it. Corresponding ribs occur upon the mesial depression of the ventral valve and the side slopes adjoining the depression. The material representing it is too limited to warrant an identification with any described species. *H. orientalis* is the trans-Pacific representative of *H. texana*.

Formation and locality.—**Upper Cambrian:** (C64) Upper limestone member of the Kiulung group [Blackwelder, 1907a, pp. 37 and 42 (first list of fossils), and fig. 10 (bed 20), p. 38] 2.7 miles (4.3 km.) southwest of Yenchuang, Sintai district, Shantung, China.

Huenella texana (Walcott).

Plate CIII, figures 1, 1a–i.

Camerella sp.? Shumard, 1861, Am. Jour. Sci., 2d ser., vol. 32, p. 221. (Mentioned; see below for copy.)
Syntrophia texana Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, p. 294. (Original mention copied and species discussed as below as a new species.)

This may be called the plicate representative of the group of species referred to the Syntrophiidæ. It is intimately connected with the smooth forms by a series of shells that vary from 16 ribs on a valve to 1; the extremes are shown by Plate CIII, figures 1d and 1e. In form *H. texana* is much like *H. abnormis* (Walcott); also in the cross section of its spondylium. They differ in the extravagant development of the plications of *H. texana*, a feature characteristic of a large series of specimens.

The average size of the larger shell is width, 8 mm.; length, 6 to 7 mm.

It is probable that this is the shell referred to by Dr. Shumard [1861, p. 221] as *Camerella* sp.?. He said of it:

> There are several specimens of a small brachiopod in the Texas state collection, from the Potsdam sandstone of Morgans Creek, Burnet County, which appear to belong to the genus *Camerella* recently created by Mr. E. Billings. Unfortunately, however, they consist merely of detached and imperfect valves too much weathered for satisfactory determination and description.

Formation and locality.—**Upper Cambrian:** (68) *Interbedded sandstone and limestone, Packsaddle Mountain, Llano County;* (71) limestone in Cold Creek Canyon, Burnet County; and (69) limestone near Honey Creek, Burnet County; all in Texas.

Huenella texana læviusculus (Walcott).

Syntrophia texana læviusculus Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 294–295. (Characterized and discussed as below as a new variety.)

A variety occurs in Texas with a few traces of plication in the sinus; and with one, two, or three strong plications on the dorsal fold, or none at all; it approaches *Huenella abnormis* (Walcott) in some of its extreme forms where the ribs are large on a prominent mesial fold. In most young shells the sinus and fold are inconspicuous, the convexity is very moderate, and the shell smooth; nearly all the characters of the adult are missing.

A group of young shells from Honey Creek shows only the smooth, slightly convex forms, with only slight ventral sinus and dorsal fold. One larger shell associated with the young shells has a relatively deep sinus and a trace of a plication.

FORMATION AND LOCALITY.—**Upper Cambrian:** (69) Limestone near Honey Creek; and (71) *limestone in Cold Creek Canyon;* both in Burnet County, Texas.

HUENELLA VERMONTANA n. sp.

Text figure 76.

This species is represented by a single specimen of the two valves united. It is somewhat imperfect near the beaks.

Valves moderately and about equally convex, with the dorsal valve subcircular in outline and the ventral more elongated at the beak. Hinge short; cardinal angles rounded.

Surface marked by low, concentric ridges of growth and numerous fine, rounded, radiating ridges that increase in number from the umbo to the margin by both bifurcation and interpolation of new ridges. A low, moderately broad sinus occurs on the anterior half of the ventral valve and a narrow median fold on the dorsal valve. Where the surface of the shell is exfoliated the shell appears to be minutely punctate.

FIGURE 76.—*Huenella vermontana* n. sp. A, Ventral view of a specimen. A′, Dorsal view of same specimen. A″, Side view of the same specimen, showing the two valves united.

The specimen is from Locality **319s**, near St. Albans, Vermont (U. S. Nat. Mus. Cat. No. 58312).

The ventral valve has a length of 11 mm.; width, 9 mm. The convexity of the two valves is 6 mm.

Observations.—This shell differs from all known species of *Huenella* by its finely ribbed surface. In this respect it recalls *Swantonia antiquata* (Billings) (Pl. CIV, fig. 5). It occurs in association with *Paradoxides* in an intraformational conglomerate.

FORMATION AND LOCALITY.—**Middle Cambrian:** (319s) "St. Albans formation," at St. Albans, Franklin County, Vermont.

Genus CLARKELLA Walcott.[a]

Clarkella WALCOTT, 1908, Smithsonian Misc. Coll., vol. 53, No. 3, pp. 110–111. (Described and discussed as below as a new genus.)

Clarkella WALCOTT, 1908, idem, vol. 53, No. 4, Pl. XI, and pp. 142 and 148. (Classification of genus.)

General form rotund, unequally biconvex. Surface smooth or marked by concentric striæ and lines of growth. Ventral valve convex at the umbo and with a strong, broad median sinus; area low and divided by a relatively large delthyrium. Dorsal valve convex at the umbo, which is extended forward into a strong, broad median fold. Cross sections of the valves near the apex and beneath the umbo show a spondylium supported by four or more septa that divide the umbonal cavity into five chambers.

Thin sections of the shell of the type species show it to be fibrous and with many minute pores arranged in lines radiating from the beak to the front and side margins of the valves.

Type.—Polytæchia? montanensis Walcott.

This genus is known only by the type species from the Lower Ordovician of Montana. It is distinguished from *Polytæchia* Hall and Clarke [1892c, p. 239] by an open delthyrium, smooth surface, and presence of septa and spondylium in the dorsal valve. It differs from *Syntrophia* and *Huenella* in having several septa supporting the spondylium, and also from *Huenella* in having a smooth nonplicate surface.

The generic name is given in recognition of the work of Prof. John M. Clarke, of the Geological Survey of New York, in connection with Prof. James Hall, on the fossil Brachiopoda.

[a] Prior to the definition of the genus *Clarkella* the type species was placed under *Polytæchia* [Walcott, 1905a, p. 295].

Clarkella montanensis (Walcott).

Plate CIV, figures 2, 2a–d.

Polytœchia? montanensis Walcott, 1905, Proc. U. S. Nat. Mus., vol. 28, pp. 295–296. (Characterized and discussed as below as a new species.)

This shell was placed with *Camerella calcifera* until sections were made showing the numerous septa supporting the spondylium and cruralium. In general form it is close to *Syntrophia rotundata* Walcott, differing in the numerous supporting septa of the spondylium which divide the umbonal cavity into five chambers. The material available for study does not show the area in very good preservation; a delthyrium exists in the area of the ventral valve, which is all that can be said.

This species appears to be a direct descendant of the smooth, convex forms of *Syntrophia*, like *S. rotundata*.

Formation and locality.—**Lower Ordovician**: (302j) Limestone on the east side of West Gallatin (Gallatin) River, above Gallatin, Gallatin County, Montana.

INDEX.

In this index **black-face** figures refer to locality numbers, light-face figures refer to pages. The *main reference* to each genus and species (the page reference which is usually put in black-face type under the old scheme of lumping all references together, or the page reference which will be used in the future synonymy of the genus or species) is given first and is invariably preceded by the word "described," even if the genus or species is little more than mentioned on the page given.

References to the description of certain features of a species or to comparisons with other species are indexed only if the description or comparison occurs on some other page than the one on which the species is described.

The table of synonymic references, on pages 27–98, may be regarded as a completely cross-referenced index to the synonymy in the monograph, as each name in that table is there given in the form in which it appears in the synonymy of the species to which it is now referred. This index therefore includes only those synonymic references that appear in connection with the description of the genera and species, all synonyms being placed in quotation marks.

This index gives the numbers of all the localities in any country, province, State, county, district, or place, as well as the numbers of all the localities identified from the different formations or other stratigraphic units. These numbers are tabulated on pages 160–291, where full information is given as to species included, authority for citation, correlation and comparison with other localities, and the stratigraphic section (pp. 123–159) in which the locality is placed or with which it is correlated. For these reasons this index includes no reference to the localities given in connection with the description of the species. The names of species given under the heading "Localities," on pages 160–291, are not indexed as appearing on those pages, but the page on which each brachiopod there named is described appears in the index, and on this page are given not only the numbers but detailed descriptions of all localities from which the species has been identified.

Geographic names that have been passed on by the United States Geographic Board are spelled in accordance with that board's decisions, but a few variant familiar spellings have been inserted in the index with cross references.

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